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CREATIVITY AND BRAIN MECHANISMS

NOURI JAFFAR

Baghdad, Al-Zahra Press
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Corrigenda

Please read as follows:

Page	Line	
1	3	bearing
14	5	observation
18	11—13	which have previously discoverd
19	11	Archemedes
22	12	devoted
31	27	mechanisms
43	5	surprisingly low
48	7	Utah
48	12	Utah
51	9	far
61	10	well known
68	14	And Wallace wrote,"
74	1	reaction
81	10	Galen... A.D
84	21	form
85	22	tactile perception
96	23	psychology introduced
97	1	Nervertheless
100	15	gives
104	24	regulation
109	16	stimulation
110	29	contact
111	26	storing
113	15—16	play a special role
116	2	areas
119	1	connected
119	4	thought in the left — dominant hemisphere
125	3	Institute
128	23	on the one
135	13	latter
137	16	knots
137	27	knot
140	2	later
149	9	manifestation
153	23	in the
172	24	fact. lapped
174	5	ancient. hamonoid
175	7	dementated
177	16	weak
177	19	stronly
185	10	particular
185	13	experience
203	23	nurture
205	17	leisure
205	29	instruction
207	9	voluntarily

Page	Line	
214	17	competitions
217	6	devoted
218	4—5	is necessary
225	17	foresee
233	1	solemnity
233	7	passively
234	17	lesson
273	21	uenced
278	12	monumental
280	24	is
281	7	is
281	25	absorblion
282	6	architects
284	19	architects
286	30	acknowledged
290	25—26	brain to sabotage
295	1	perfect
298	1	outward
301	3	orientation,
301	10	excer
302	6	privilege
302	27	distorted
308	25	determining
310	5	Genius
310	7	genius
240	17, 18	fantasy
255	3	they had

Page	Line	
256	15	Many
258	7	sufficiently
261	5	Idealism
261	31	More... offers
310	18	journey
311	14	word
312	26	Leonardo
320	22	which constitute
322	16	parietal
327	15	For
327	30	exercising
330	8	Alternatively
333	10	arithmetical
333	14	opertions, is essential
334	16	external
335	13	arithmetic
335	3	thought
335	15	called
335	27	an
336	5	requires
336	8	For
336	18	not only
338	11	no
341	14	excluded
347	7	established
347—350		genius
350	11	creator

UNIVERSITY OF SHEFFIELD

Sheffield S10 2TN Telephone 0742 78555
Department of Psychology
Professor Kevin Connolly

13 January 1975.

Dr. Taha Ibrahim Al-Abdallah,
President,
University of Baghdad,
Baghdad,
Iraq.

Dear Dr Al-Abdallah,

I am writing to you at the request of professor Nouri Jaffar, a member of your University, who has recently spent some time as a visiting professor in my department in the University of Sheffield. It has been a great pleasure to have Professor Jaffar with us and my colleagues and I have benefitted greatly from some stimulating interactions with him, my only regret is that it is not possible for him to stay any longer.

Dr. Jaffar settled into a different country and culture very rapidly and immediately began to work extremely hard on his research project. I was impressed not only with the speed but with the professional way in which he went to work on his studies on creativity and brain mechanisms. He spent many long hours each day in the Library reading the relevant literature, reviewing it and critically evaluating it. He has also managed to write at the same time a very substantial manuscript on this topic which I had the pleasure of reading. It is clear that Professor Jaffar has a very good grasp of the issues involved and has performed a most valuable function in bringing together a lot of very different material bearing upon this problem. I hope it will be possible for him to publish this work when he returns to Iraq. I have already indicated to him that I shall be extremely grateful if he would let me have a copy of this if it is possible to publish it, or at least circulate it in mimeograph form.

I should be extremely happy to have Dr. Jaffar spend a subsequent period as visiting professor in my department if this proves possible at any time in the future.

Yours sincerely,
Kevin Connolly

THE NATIONAL ASSOCIATION FOR

GIFTED CHILDREN

10 February 1975

HC: ce

Dear Professor Jaffar,

I am very glad to welcome you as a member of this Association and hope that you will find our work of interest. I know that we shall considerably benefit by keeping in touch with you in view of the study you have made concerning gifted children, particularly on creativity and brain mechanisms.

We very much hope that you can attend the World Conference to be held in London this September. It is the first of its kind to take place and as you will see from the enclosed brochure it is being run with the cooperation of our government. We hope that it will lead to a series of such Conferences in different countries and it would therefore seem of great importance that somebody with your interest in gifted children should be in on these Conferences from the beginning.

We have been fortunate in securing some of the leading experts in understanding the needs of gifted children.

Yours sincerely,
Henry Collis,

Professor N. Jaffar,
c/o College of Education,
Wazzirya,
Baghdad,
Iraq.

INTRODUCTORY REMARKS

* Creativity means originality, innovation. It denotes, in the realm of human thought, the contributions or additions to the field of human knowledge new ideas or theories and, in the domain of material civilization, it means the discovery of something already in existence but in a hidden form.* In other words, creativity takes sometimes the form of inventing something, tangible or conceptual, while it reveals itself, under other circumstances, in discovering something already there but unknown whether it is material as in the case of a star, an atom or a particle, or a relation between two things as in the case of Archimede's or between ireas as in the realm of mathematics and theoretical sciences.

* Creativity may be defined, quite simply, as the ability to bring something new into existence. But since human beings are not able to make something out of nothing, the human act of creation always involves a reshaping of given materials, whether physical or mental. The "something new", then, is a form made by the reconstitution of, or generation from, something old. On other hand, a man may think a thought which for him is a new thought, yet it may be one of the most common thought in the world when all thinkers are taken into account. His act is a creative act, but the "something new" that is produced is something new in the population of thoughts he can claim as his own, not something new for mankind as a whole. Great original thoughts or ideas, as we

shall specify later, are those that are not only new to the persons who think them but almost to every one. These contributions are creative in perhaps a stronger sense of the term; not only are they the results of a creative act, but they themselves in turn create new conditions of human existence. Creative power of an outstanding order is marked by the voluminous production of acts that can claim a notable degree of radical originality.

In discussing creativity, it is important to distinguish between its two distinct aspects : The creative process and the creative outcome. However, these two aspects are always organically interwoven since the creative process leads to creative products, and the creative products themselves cannot be obtained otherwise than through the process of creation(1)". Creativity, in its two interconnected traits, is of a hierarchical order or gradation, and the climax of it is the seat of genius : the level of extreme height of creativity. Men of Genius are a handful of the most brilliant personalities in every field of human knowledge and social activity throughout the entire history of mankind. Their contributions to scientific and social thinking are landmarks and turning points in the course of human history. They positively create progressive conditions of human advancement, transceding and transforming the generally advancement, transcending and transforming the generally accepted ideas by introducing new everlasting principles that defy old ideas and change radically man's views of the world and his place in it. In the field of mathematics and natural science, for instance, Euclid, Copernicus, Galileo, Newton, Gauss, Darwin, Pavlov and Einstein are truly men of genius. Others are emiment creative. This means that not all creative scientists are genius as previously supposed by some famous investigators such as Galton, Lombroso. Kretschmer and Terman.

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(1) **This is true also of instances where research on one Phenomenon reaults in the discovery of another. This is known as "Serendipity" taken from a fairy tale: The three princes of serendip - as they travelled, they were making discoveries by accidents.**

Euclid, about whose life nothing is known with any certainty, flourished probably during the time of the first Ptolemy (306 — 283), to whom he is supposed to have remarked that there was no royal road to geometry. His most famous and most advanced texts are the thirteen parts of the *Elements;* The *Elements* is a book without parallel. By the year 1880, it had appeared in about 500 editions and more than 1000 editions have appeared since the invention of the printing, and before that time manuscript copies dominated much of the teaching of geometry. For over two thousand years it was the principal and practically sole manual on geometry for scholars of both the Occident and the Orient. Most of our school geometry is taken, often literary, from the eight or the nine of its thirteen parts; and Euclidean tradition still weighs heavily on our elementary instructions. For the professional mathematician the *Elements* has always had an inescapable fascination (even if though pupils often sighed) and its logical structure has influenced scientific thinking perhaps more than any other text in the world. Euclid's treatment is based on strictly logical deduction of theorems from a set of definitions, postulates and axioms. One can say all kinds of harsh (and true) things about Euclid's axiomatics. But one should never forget that the scheme itself has become, since that time, the canonical modal for constructing every branch of mathematics. And of course one must never forget that the *Elements* present an excellent piece of writing by a skilful master, a perspicacious scholar and a magnificent teacher. That explains and justifies the universal admiration of mathematicians for Euclid and his *Elements*. Let us add that this book brought to the field of mathematics scores of young men who later became the world's greatest mathematicians.

Copernicus (1473—1543) was the founder of modern conception of the universe. He was the inaugurator of the scientific age in which we live. We owe our modern scientific way of looking at things more to him than to any other man, and in this sense his contribution was more important, and of a higher order than that of any of his successors. There have been many who were better mathematicians and experementers, and much skilful in making technical use of new point of view, but he was its author. He was the first to believe with complete certainty that the earth revolves round the sun, and support his arguments with sufficient proof. Thus., he shattered the ancient human egocentric conception of the universe, and revealed mankind's true place in it. He was the first to give us a true insight into the magnitude of the cosmos. In his discussion of whether the earth moved round the sun, or *vice versa*, he showed a strong and clear understanding of the relativity of motion. In his midst of busy life of affairs, he quietly elaborated his revolutionary system of the world, through forty years of private labour, reading, collecting data, observing, calculating and revising his work over and over again. His work stimulated the questioning of the generally accepted ideas at his time in science and in all aspects of life. Some men soon pushed the implications of his conclusions as far as they would go, and Bruno, the boldest of these, was burnt at the stake for his pains by the Inquisition on February 17th 1600. On the other hand, Luther, referred to Copernicus as that new astrologer who wanted to prove that the earth was moving and revolving, rather than the heaven or the firmament, sun and moon. "This fool wants to turn the whole art of astronomy upside down. But, as the Holy Scripture testifies, Joshuia ordered the sun to stand still, and not the earth".(2)

Copernicus' work was put on the Index of banned books by the Papal Order. And for the next 200 years or so the professors of the European Universities were ordered, before being appointed to their chairs, to take a solemn public oath that they would not disseminate the Copernican heresy.

Towards the end of the 13th century Aristotle was proclaimed Christ's forerunner in the explanation of nature. Up to the 17th century any criticism of Aristatle was regarded as subversive to the tenents of the fathers of the church. A decision of parliament in Paris dated 24 August 1624 forbids, under penalty of death, any person "to hold or, especially, expand any truths controdictory to the teaching of Aristotle" Aristotle explained nature by ascribing every property a mystical attribute, which explains things on the level of mentality of a five-year old child. Why is a thing warm ? Because it contains heat. Why do bodies fall to the ground? Very

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(2) Quoted by Crowther, J. G, Six Great Scientists, London, Hamish Hamalton, 1455, P. 36.

simple they are borne down by their inherent ponderability. The more ponderous a body the faster it falls. The idea that the earth acts on a falling stone is utterly unaceptable to Aristotle. A body's behaviour is determined by its nature: by its inherent properties.

But when experimental natural science appeared on the scene it became impossible to uphold Aristotelean science. The new period in science began in the 16th century. It was heralded by the discoveries of Copernicus. Observation and experimental investigation began to replace scholastic discourse about nature. This change of accent is especially apparent in the works of the great Italian, Galileo, founder of experimental physics. Thus, the verbal castle built by Aristotle was reduced to rubbish.

Galileo (1564—1642) was the first modern scientist. His works are the earliest in which the scientific reader today feels quite at home. He was the first to work out the scientific method completely. He also invented physics, and made Copernicus imagination concrete. More than all this, important as it is, he was an outspoken supporter of free intellectual inquiry. From the first, he showed himself disputatious; the custom in his days was for students to listen in a profound defference to their professors, but Galileo argued about everything on its merits. He was not content to learn what was said, but independently discussed its meaning. Though he always spoke with respect to Aristotle, the greatest scientific authority at that time, he was quite without reverence for the exaggerated authority accorded to him, and contradicted his views when they seemed to him wrong. This was regarded as bordering on blasphemy. He was nicknamed "Wrangler" and engendered hostility as a turbulent intellectual from the beginning of his student days. Being endowed with almost unparalleled intellectual strength and energy, he swiftly produced a profound disturbance. To Galileo we owe the new mechanics of freely falling bodies, the beginning of the theory of elasticity and a spirited defence of the Copernican system. Above all we owe to him, more than to other men of his period, the spirit of modern science based on the harmony of the experiment and theory. He discovered the principles of the science of motion of bodies. The ground was now clear for Newton to invent the mathematical technique for dealing with them and built the main structure of modern physical science. Even at the age of seventy-three he was still making discoveries. In 1637, he lost the sight of his left eye, and in 1638, became totally blind. "Alas", he wrote, "your dear friend and servant Galileo has been for the last month helplessly blind; on this heaven, this earth, this universe, which I by marvellous discoveries and clear demonstrations had enlarged a hundred thousand time beyond the belief of the wise men of bygone ages, hence forward for me is shrunk into much smaller space as is filled by my own bodily sensations".(3) His health finally declined in 1641, and on January 8th 1~~9~~642, he passed away. The Inquisition refused the court and citizens of Florence to give him public funeral, and erect a marble mausoleum for his grave. Permission for the latter was not obtained until 1737. The intellectual lesson to be learned today from Galileo's struggle, how to emulate his courage and avoid his mistakes, are at least as important as the natural truths that were learned from his marvellous physical discoveries. Thus mankind is trebly indebted to him for showing it how to make discoveries in the realm of nature, how to expound and fight for the truth, and also for serving as a warning of errors to be avoided in dealing with scientific results which have a moral and social significance.

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(3) Ibid, P.P. 86—87.

It is said that the first stage of wisdom is the discerning of falsehood and the second is perception of the truth. If this is true, Galileo completed both stages. For seventeen years he taught the Ptolmaic system, while harbouring doubts of its accuracy. These doubts stood in need of confirmation by facts. It was the telescope directed by Galileo at the stary heavens which introduced these facts. Now it was to proclaim openly to the entire world the correctness of the views of Copernicus. As a scientist Gulileo believed in the conclusions of reason. He, however, forgot that in the Scriptures sin and knowledge were from the beginning inseparable : it was precisely the thirst for knowledge which forced man to bite upon the apple from the tree of knowledge, from the point of view of the ecclesiast, an evident crime had taken place a-gainst the principles and norms which had been given and legilimatized for eternity.

The Polish ecclesiastic Copernicus first looked at the world in the modern way. The Italian master of profane knowledge, Galileo, showed how to investigate it. Armed with the new point of view and method, Newton ,1642—1727) at one blow gave a comprehensive account of the whole physical universe as then known. Newton showed by rigorous mathematical deduction how the empirically established laws of

Kepler on planetary motion found their explication in the gravitational law of inverse sequares and grave a dynamical explanation of many aspects of the motions of heavenly bodies and of the tides. No single intellectual feat in all history has approached this in brilliance. He got more results, of greater importance, and in a shorter time, than any other scientist.

The question of whether Euclid's parallel postulate is an independent axiom or can be derived from other axioms had puzzled mathematicians for two thousand years. Gauss (1777—1855) was the first man who belived in the independent nature of the parallel postulate, which implied that other geometries, based on another choice of axioms, were logically possible. Thus, he was the first to come to the idea of non-Euclidean geometry. As a mathematician he was, without any doubt, far above Bolyi and Lobachevsky. He never published his thoughts on this subject but wrote in his private letters-and there is no reason to doubt that what he wrote was the truth- that the basic ideas of non-Euclidean geometry were clear to him as early as the end of the 18th century. At that time Lobachavsky had not yet begun studying in the secondary school, and Bolyi had not even been born. Causs was described as the prince of mathematics and Striuk wrote, with complete justification, that "on the dividing line between eighteenth and nineteenth century mathematics towers the majestic figure of Carl Friendrich Causs".(4) He started school when he was seven, the school was run by the virile brute Buttner whose idea of teaching the hundred or so boys in his charge was to throw them into such a state of terrified stupidity with his whip that they forgot their names. When Carl was ten, Buttner gave the class an exercise which consisted of writing down all the numbers from one to hundred and adding them up. The pupil who finished first led his tablet in the middle of the big table in a few seconds. He calculated that: $100+1=101$; $99+2=101$; $98+3=101$ and so on there are as many pairs as there are in 100. The answer therefore was : $50 \times 101=5050$. Buttner was astonished, and obtained the best textbook of arithmetics available and presented to the boy, and said "you are beyond me, I can teach you nothing more. When Carl was thirteen, his teacher of mathematics handed back his first exercise to him and told him that it was unnecessary for him to attend the class any more.

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(4) Struik, D. J., A Concise History of Mathematics, New York, Dover, P. 140.

After Newton had shown, by means of the law of gravitation, that all the material universe could be conceived as one precisely operating machines it was natural to look for a comparable idea in the world of living organisms. This was found by Darwin (1808—1882) in his theory of Evolution. Darwin brilliantly showed that all living organisms are related members of one organic system; each is a single branch on one great tree of life.

When Pavlov (1849—1936) - the initiator of modern scientific work on the brain - studied the functions of the cerebral hemispheres by the method of conditional reflexes, he found that the primary function of these hemispheres was to analyse and synthesize the stimuli which an organism receives from the external world and to construct circuits of new temporary connections by which the organism can adapt to the changing conditions of its environment. The higher the animal is on the evolutionary scale, the more complex the analysis and synthesis of external stimuli and the richer and more varied the network of temporary connections. Both these mentioned processes are basic aspects of the activity of human brain. As opposed to animals, social man is exposed to abstract and social signals of reality. These are contained in language and constitute the second signalling system of reality. The existence of this system immeasurably complicates the activity of the human brain and creates a basis for the assimilation of experience common to all mankind and for the development of those higher forms of mental life which are the inalienable essence of man.

One of Pavlov's traits is his ability to work with the minimum and almost primitive scientific equipments and under very difficult laboratory conditions. Moreover, his was a difficult period especially during the great Socialist Revolution of October 1917. His animals were perishing one after another and the food crisis hindered his normal work. But he did not lose his enthusiasm. When the electric light failed and even candles were unobtainable he operated by the light from splinters wood; when the tram service stopped he came to the laboratory on a bicycle although he had not fully recovered yet from a serious thigh fracture. And this is the story-of his tragic death: "Pavlov died in harness, the hope of every ardent investigator. After the International Physioological Congress in Leningrad in August 1935, he worked actively in his several laboratories and clinics,.....

The day of his death, February, 27, 1936, while sufferring collapse, with pulse rate 150, he summoned a neuro-pathologist to know whether his symptoms might not be interesting to science .... It was only in the very last minutes of his life .... that Pavlov ceased to make scientific absrvation on himself ..... Finally he raised himself on his elbow in bed, and reaching for his clothes, with the same impatient, rushing energy that had for times without number tensed his every muscle and fiber, vibrated through him like a thunder - storm through a forest, he struggled to arise: it is time to get up. Help me. I must dress; That was the end. He fell back dead. These were his last words. Like many other heroes, his closing thoughts were of action." (5)

The splendent edifice of physical science erected in the 19th century did not last for long. It collapsed in 1905, the year in which one of the most remarkable creations of human genuis –the theory of relativity– was enunciated by the 25–year old Einstein. With the help of the strictest mathematical logic, on several dozen pages, he set forth the corollaries of two axioms. Corollaries so unusual that they crushed existing concepts and shatered the foundations of physics. The axioms came from different fields of Physics and were brought together for the first time in Einstein's paper. What are these axioms? The first one states: if two observers are in uniform rectilinear motion with respect to each other, they are both in absolutely identical conditions. Which is to say that there is no way of determing which of them is moving and which is at rest. It is meaningless to ask who is in true motion. There is no such thing as absolute motion. All motion is relative. The second axiom is rather another case. Although the postulate that the velocity of light is always the same for different observers irrespective of their motion was known to physicists, they regarded it as strange experimental fact that still had to be investigated. Einstein elevated this strange postulate to the status of an axiom. The phenomenon was discovered by Michelson and Morley in 1887. Various attempts to reconcile Michelson's experiment with 19th – century physics were made unsuccessfull up to 1905. Joining of the two axioms together meant an entirely new formulation of the relativity principle. What holds for the velocity of light holds good for other manifestation of electromagnetism.

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(5) Gantt, W.H. editor, Conditioned Reflexes, London, Lawrence and Wishart, 1941, PP. 34—35.

Einstein (1879—1955)was the most famous scientist of the twentieth century. He received an acclaim, among scientists and the public at large, which can be compared with that which was accorded to Newton and Darwin. This is because his discoveries, like theirs, have been of the highest technical and general significance. Modern theories of physical nature are of three kinds. Classical theory, quantum theory and the theory of relativity. Einstein made major constributions to the first two, and personally created the third. Moreover, he did all this in one year, 1905, when he was twenty-five years old. He was then a patent office clerk in Switzerland, and had not met a leading physicist. Nor was this a chance outburst of genius. By ten years of the most intense and unremitting intellectural toil, from 1905 until 1915, he succeeded in extending his theory of relativity from local physical processes to the movement of the whole universe. It was this latter extenision of his theory which most impressed mankind in general. In addition, he made many particular discoveries, any one of which would have gained for him a place amony important physicists. For instance, his proof that mass and energy are equivalent fallows as a simple deduction from his relativity theory of 1905. This result is the basis of the precise theory of the release of atomic energy. After many years of delicate health he died at Princeton on April 18th. 1955, occupying himself with the problems of science and peace, up to the day of his death. In collaboration with Russell and six eminent scientists, he prepared a declaration warning the world of the danger of hydrogen bomb warfare to the human race. He signed the declaration a few days before he died. His struggle for the responsible use of science continued to bear fruit even after his death. While he was busying himself in his last hours with the noblest of all aims, the welfare of humanity, scientists were preparing the celebration of the fiftieth anniversary of his greatest discovery, the theory of relativity. While he was thinking about humanity, humanity was thinking about him. But he died just before the celebrations were due to take place. He bequeathed his brain for biological research, and the rest of his body was cremated.

The most outstanding social quality of all these men of genius was their tremendous belief in life and the possibilities of human endeavour. Their achievements and their example renew our confidence in human destiny, by reminding us of what men are capable when they have the ability, the determination, and will to solve the most difficult problems. Their successes in discoverning the secrets of nature have placed astounding new powers in the hands of mankind. These are men of genius. Creative, men, below this level, are too many and every nrmal human being is potentially creative as we shall see. Creative men, below the rung of genius in the ladder of originality, are in fact eminent, competent, brilliant, bright, outstanding famous or cleaver, starting, from Archimedes down to Nobel Prize winners so far as their contributions to human knowledge are concerned. Their brain mechanisms, which will be specified later, judged by their products, are not markedly distinct from those of the ordinary people. But their intellectually acquired inclinations, social conditions, and their perseverence are radically different. They used their brain mechanisms to their utmost and concertedly in their fields of specialization. This, however, does not exclude the possibility that some of them were potentially genius in their brain mechanisms, which we shall specify later, but their actual products cannot elevate them to the higher rank of genius.

The term "association" is a generic conception, i.e. a combination of that which was previously separated, a joining or generalization of two points in a functional relationship, a conditional reflex, a linkage of two things or phenomena which were not previously connected. But this is a particular case of joining and is of a special significance. When the nervous connections in the active region of the cerebral cortex are coupled, this makes the birth of a new idea. Creative act of thinking cannot be understood without considering the role of previous connections; no creativity can take place without the support of previous experience. psychologically equivalent to a creative act of thought. However, a new stimulus evokes a fresh reaction which is previous experience, reflected in the brain in the form of an old association, intervenes, as it were, between the new stimulus and the response, yet at the same time links the stimulus with a response with which it has never previously been connected. Thus research directed to a physiological analysis of the creative act of thinking confirms the conclusions reached by Sechenov(6) many years ago on the basis of choice in the process of inference: "What is really new in such cases is either that objects are joined which have never joined before, or that new sides of them have been joined which have only been dicovered in the last analysis, or which have previously discovered in the last analysis, or which have previously simply es-caped attention." Thus it was only when Archimedes, for instance, perceived the connection between the weight - volume matrix that he was able to produce a creative idea. Gutenberg's invention of printing with movable type was based on bringing together the idea of the seal for stamping an impression and the idea of the wine - press for exerting powerful steady pressure. The genesis of the Eureka act, then, is the suddent shaking together of two previously unconnected matrices. Therefore, it was the connection between two unconnected phenomena that constituted the basis of the act of creation. In other words, creativity is a process of rearranging familiar facts into relationships so that new results emerge easily and effectively; the essence of the creative process is wrenching away an object or idea from its familiar contex and viewing it in an entirely new context: seeing, for example, the fall of an apple not in connection with its ripeness, but with the interconnections ofthe motions of the sun, earth and the moon. Here there is, of course, overemphasis on major discoveries in the discussion as published, but in this case the same treatment can very easily be applied also to miner ones. Indeed it provides a basis for some kind of meassure of the degree of creativity in a particular case. The measure lies perhaps in terms of the distant apart of the two things associated – their degree of unrelatedness before the event. Moreover, it is not necessary to embark on a dis-cussion of whether there is such a thing as a totally new idea, an idea of absolute novelty, created *de novo* and not from previous ideas,. It is merely specious to deny that new arrangements of existing units to do contain geniune novelty,.

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(6) Sechenov, I. N., Selected Physiological and Pasychological Works, Moscow, Foreign Languages Publishing House, No date, PP. 588—589.

Every one is acquainted with the delightful story of Archimodes, how he sprang out of his bath and ran as he was throughout the streets, crying out: Eureka, Eureka. From this burst we may gather that he achieved something wonderful even for him. What had he done? As is well-known, he had been ordered to find out whether a crown, alleged to be made of pure gold, had really been adulterated with any baser metal. And he had suddenly invented a means of this end at the moment of getting into his bath. For he observed the water rising in consequence. He perceived that the cubic area of the rise must be exactly equal to that of his immersed body. Forthwith he realized that the cubic area of the crown could be similarly measured by immersing it in water. The rest of his problem-since he knew the weight of both of gold and of baser metals-presented to him no difficulty. Thus the crux of the invention, consisted in a measurement being supplied by immersion in water; this was actually observed in relation to his own body and then was in idea – transfered to the golden crown. The same principle is true also of the invention of steamengine. How it was really invented no body knows. But at least the anecdote told about Watt is characterestic of what might happen. Supposedly, he noticed the movement of the lid of a kettle of boiling water, and was inspired by the idea that such an events on a large scale might exert very great force. Here the relation, actually observed between a small quantity of steam and the movement of a light body, is transferred mentally to a large quantity of steam and thereby creates the idea of the movement of a heavy body. This means that one thing points to another, suggests it. Although (what a thing suggests but is not as it is presented) is creative, an incursion into the novel. It involves some inventiveness. What is suggested must, indeed, be familiar in some context; the novelty, the inventive devicing clings to the new light in which it is seen, the different use to which it is put. When Newton thought of the theory of gravitation, the creative aspect of his thought was not found in the material. They were familiar; many of them were commonplaces - the sun, the moon, the planets, weight, distance, mass, sequars of numbers. These were not original ideas; they were established facts. His originality lay in the creative combination of these familiar acquaintances: The unfamiliar context. The same is true of every striking scientific discovery, every great invention, every admirable artistic production. Only silly people identify creative thinking with the extraordinary and fanciful; others recognize that its measure lies in putting every day things in a new context which had not occured to others before - the operation is novel. The first requirement of the creative product is novelty; it must be original. But novelty or originality needs furhter specification for one must at once ask, within what frame of reference or a range of experiences is the product original – that of an individual, or of a group, or of mankind? Much that a young child experiences and many of his ideas will be new to him and in that sense creative for him, but if these experiences and ideas are had by practically all children they are not creative products for the society in which the child lives. Similarly, a man may think a thought new to him, yet it may be one of the most common thought in the whole world. Thus the creativeness of a product when judged in terms of novelty or originality is always relative to a given population of products; and those who are most creative are the ones that are novel or original in the experience of an entirc civilization of all mankind. Nevertheless, an infant who dis-covers what can be done with blocks, or who finds out what he can make by putting five apples and five apples together, is really discoverer, even though every body else in the world knows it. There is a genuine increment of experience; not another item mechanically added out, but enrichment by a new quality. The charm which the spontaneity of tiny children has for sympathetic observers is due to the perception of this intellectual originality. The joy which children themselves experience is the joy of intellectual constructiveness, of creativeness. In other words, as soon as the infant begins to expect he begins to use something which is now going on as asign of something to follow; he is, in however a simple fashion, creating, for he takes one thing as evidence of something else, and so recognizing a relationship. Any futher development, however elaborated it may be, is only an extending and refining of this simple act of inference. All that the creative scientist can do is to observe what is going on more widely and more minutely and then select more carefully from what is noted just these factors which point to something to happen. This means that creativity occurs at practically all ages, in all cultures and in all fields of human life; the social enveronment fosters its manifestation. Young children come to life with an insatiable creativity and an enthusiasm for learning, both of which diminsh in some cultures and especially as they proceed through the school which actually dulls their creativity.

The study of creativity as a psychological phenomenon goes back to the ancient Greek thinkers, especially Aristotle, but its theoretical foundations were speculative and not educational implications of Darwin's theory of natural selection. Huxley made a trenchant attack on Helvetus theory as well as on Rousseau's. Galton carried the argument futher by maintaining that the rise and fall of nations, and the progress of human civilization in general, was dependent on the innate qualities of the race and its constituent communities, and in particular on the distinctive innate qualities of their chosen leaders. Educationally, schools are to be reorganized so as to make the most and the best of the human material which nature supplies.

Here, in picturesque, is how Plato introduceed his theory of individual differences in his Republic: "You, Citizens, are all brothers. But God who created you has put different metals into your compositions – gold into those who fit to be rulers, silver into those who are to act as their excutives and in those whose task will be to cultivate the soil or manufacture goods he has mixed iron or brass. Most children resemble their parents. Yet occasionally a golden parent may beget a silver child or a silver parent a child of gold; indeed, any kind of parent may at times give birth to any kind of child. The rulers therefore have received this paramount charge from gods – that first and foremost they shall scrutinize each child to see what metal has gone to his making, and then allocate or promote him accordingly: for a sage has predicted that our state will be doomed to disaster so soon as its guardianship falls into the hands of men of baser metal."

During my intensive survey of the literature dealing with creativity, its nature and nurture, advanced by educationists and psychologists in the United Kingdom and the United

States, on the one hand, and their counterparts in the Soviet Union, on the others, I have found radical differences in their points of view concerning the interpretation of the nature of the creative process and of its cultivation. British and American psychologists and educationalists take their theoretical point of view, in one form or another, from the psychological framework formulated long ago by Galton and developed by Spearman and those who came after him; they interpret the nature of creativity, and all mental processes, in terms of "Intelligence" which is, in essence, a metaphysical concept. They shun its physical or bodily foundations. This concept is historically British and its pioneers are Galton who formulated it in 1867, and Spearman, an army officer turned psychologist, who developed it in 1904. The other British pasychologists such as Burt, Thomson, and Vernon subsequently crystallized it and made minor modifications especially during the years between the two world wars which showed an immense amount of psychological work devoted to the investigation of individual differences among school children in their so-called "native intelligence". This together with the development of new powerful statistical techniques, particularly "factor analysis", permitted the slow emergence of a coherent theory of the "structure of human abilities". Spearman paper, published in 1904, was the basis of an elaborated and firmly established Western psycholgical theory of the organization of "human abilities". From that paper developed the statistical techniques from which "factor analysis" developed. that was the opening statment of a debate which has long continued: "general" versus "specific" traits, the existence of group factors, and the existence of the general factor itself. The American response to the British approach was best formulated by Kelley whose ideas gave the first sign of a break away from the Spearman model. Here we see the emergence of group factors. Nevertheless, the main metaphysical assumptions were retained.(9)"

Spearman and his followers, whose psychometric investigations revealed the mutual connection between individual mental processes, concluded that particular groups of functions are based on common factors and will therefore show high degree of correlation with changes in certain specific functions and an absence of correlation with changes in others. Research such as this led to the creation of a system of psychological investigation known, as previously mentioned, as "factor analysis" embodying accurate mathematical methods for determining common and specific factors. In other words, when Western psychologists discuss individual differences in mental abilities they assume that these abilities exhibit some degree of interdepend-ence and fall into a number of groups. The functions constituting each one of these groups show, in their judgment, a high degree of correlation with each other, and the development of one of these functions is invariably associated with the high development of a particuler group of functions, but is not necessarily associated with an equally high development of the functions of the other group. Western investigators have suggested that the interdependence of individual functions are based upon certain common or group factors, and the method of the study of correletion between individual functions which they developed is called, as already mentioned, "factor analysis'. By using the methods of statistical analysis of the interconnection between changing functions, Westerm psychologists distinguish both a common factor, in fact uniting all factors of active mental activity, and special or group factors. "Factor analysis" always carries a formal, statistical character, and it is therefore inevitable that it gives only indirect information of the concrete properties responsible for the interdependence of individual mental processes.

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(9) **Kelley, T. L., Crossroads in the Mind of Man, Stanford University Press, 1928.**

It is really strange to approach psychological processes from a purely speculative or contemplative stand point, especially at the present time in which the sciences of brain have registered a tremendous advance. It is even stranger still, and painful indeed, to read, for instance, in an important official report concerning reorganization of primary education in England published in(10) 1967 by a committee of eminent educationists and psychologists that "we know distressigly little about the development of the cells and the organization of the brain." This passage is written at the time in which the development of of the cells and the organization of the brain are a common place among students of any medical school. On the other hand, it is really sad that such irresponsible statement is written in England, the country of such outstanding neurologists and physiologists: Hulings Jackson, Henry Head, Sherrington and Lord Adrian.

Western psychologists have undoubtedly made considerable progress in the study of the genesis of mental processes and of their changes in the course of their development.

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(10) Plowden Report: Children and Theil Primary Schools, Her Majesty's Stationery Office, 1967, P. 11.

Despite all of this advance, the interpretation of the structure of human abilities or their mechanisms is still grossly inadequate from the neurological and physiological stand point. However, although it would be wrong to underestimate the important work done in the direction of investingating the human mental abilities and of their assessment by various trends of "factor analysis" but it would be equally wrong to suppose that mathematical methods employed are the natural way of obtaining a genuine insight, scientifically warranted, regarding the organs performing these human abilities.

That is the main trend prevailing in the United Kindom and the United States concerning the nature of human abilities in general and creativity in particular. As for the educational measures regarding the cultivation of creativity the prevailing trend is towards voluntary procedures located outside state eductional system. "We have not undertaken or commissioned" says Plowden Committee, already mentioned, "any special study of the education of the gifted children..... We think that advice should be available to all parents who... find their children hard to understand." (11)

Regarding psychology in the Soviet Union, one can say that it used another procedure : the analysis of the structure of human psychological functions by employing neurological methods. It is easy to imagine that psychological science, by following this approach, will make new fundamental advances, and that in another decade new and important additional psychological disciplines will be created such as neurological basis of emotion and neurolinguistics. It seems that one of

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(11) Ibid., P. 305.

most important achievements of the psychology of the Soviet Union is the introduction of the historic method in studying human mental life; and this has provided a completely new approach to the structure of human abilities which is in a radical variance with the psychology prevailing in the West. Ever since the time of Pavlov it has been firmly held, that human abilities are to be regarded, not as primary native abilities, but as complex conditional reflexes, performed by certain brain mechanisms. As for their educational implications, the tendency is that their development is an integral part of the state school system.

A substantial contrabution has been made by the creation, in the Soviet Union, of neuropsychology: a branch of science which has developed recently with neurology, neuroantomy and neurophysiology. Its specific aim is to investigate the role of individual brain systems, within the whole brain as a unique integral organ in its historical setting. in producing the complex forms of human mental activity. One of its leading neuropsychologists is Aleksandr Romanovich Luria, one of the most distinguished psychologists of this century. Luria leans, of course, heavily on the contributions of a galaxy of brilliant Soviet thinkers, notably, Pavlov, Vygotsky, Leontiev, Anokhin, Sokolo, Bernstein and Galperin. For almost half a century he has, with his coworkers, combined neuropsychological research with clinical observations regarting the working brain as the organ of human psychological processes. Luria is now a professor of psychology at Moscow State University and a celebrated member of the Academy of Pedagogical Sciences. He has published many important books among them, translated into English, are the following which the author of this study has constantly consulting in presenting the psychological trend in the Soviet Union.

1: *Restoration of Functions After Injury, London, Pergamon Press, 1963.*

2: *The Role of Speech in Regulation of Normal and Abnormal Behaviour, London, Pergamon, 1961 .*

3: *Higher Contrical Functions in Man, New York, Basic Books and Plenum Press, 1966.*

4: *Human Brain and Psychological Processes, New York, Harper and Row, 1966.*

5: *The Working Brain, London, Penguin, 1973.*

Over the past two decades our knowledge of the brain structure and functions has increased more than at any time in history and Luria is uniquely fitted to herald this intellectual treasure. Early in his academic career he became an opostile of the great heritage of the previous century in the field of neuroanatomy and neurophysiology only to mould the then, current ideas into the images of the new. For the past fifty years he has refined clinical observations by devising beside tests that could be administered to brain – damaged patients and correlated with surgical and pathological reports. Consistantly he has shrewdly formed his interpretation of such correlation within the rapidly growing body of knowledge in neurological and physiological sciences. However, Luria does not say anything, so far as I know, concerning the nature of creativity, let alone its brain mehanisms. He speaks repeaedly, in general terms, about human psychological processes such as language, perception, memory, attention and thinking, and delicately specifies the brain mechaniems of each one of them within the framework of the brain as an integral organ. He speaks also about the higher cortical functions of man which distinguish the human brain from the brains of the rest of the animal kingdom. Poliakov, the eminent Soviet neurologist, who has worked at the USSR Academy of Medical Sciences since 1928, does not also speak about the brain mechanisms of creativity and genius. Luria and Poliakov affirm the qualitative differeneces between the human brain and the brains of other higher animals, that is, they reveal the specific features of the human brain common to all normal human beings. But neither Luria nor Poliakov, mention anything refarding the differences in brain mechanisms between the potential creative and genius, on the one hand, and the common man, on the other. Nevertheless, it is possible, in the light of their contributions, to postulate, first, that there are no marked differences between the brain mechanisms of the potential creative and the ordinary normal person. This means that every normal individual is potentially creative to this or that degree and that every normal human being can produce creative results in a particular field of social activity provided that he finds the proper intellectual climate and utilizes his brain mechanisms to the utmost of their capacity. Second, there are reasonable grounds to suppose that there are tremendous differences between the brain mechanisfs of the potential genius and those of other normal human beings. This is just a tentive hypothesis of a speculative assumption which waits experimental reinforcement. Since the potential genius may actualize his brain potentialities either in the domain of abstract thinking such as, for instance, mathematics and theoretical sciences, or in the field of art such as painting and poetry which depends more on visual perception, or in music which depends more on auditory perception and clever movements of the fingers, there are theoretical grounds to suppose that there are certain unique brain mechanisms, which I shall specify in the last part of this study, distinguishing the brain mechanisms of each category mentioned above.

In concluding these introductory remarks I would like to say that the contents of this text is logically divided into three distinct sections. Section one deals with the Western point of view regarding the nature of creativity and its cultivation. The second is devoted to Soviet approach. And the third contains general conclusions : The role of the intellectual climate in creating creativity and a tentative hypothesis concerning brain mechanisms of both creativity and genius.

Section One : The Western Approach

A : Creativity and Its Cultivation,

B : Creativity and Insanity .

C : Creativity and the "Unconscious"

A : Creativity and Its Cultivation:

The word "creativity", claims a British investigator,⁽¹⁾ is of American coinage and does not appear in Oxford English Dictionary. Another British⁽²⁾ investigator claims that only the edition of the shorter Oxford English Dictionery does not acknowledge the existence of the word and that "it is an omission which should be remedied". However, the term "creativity" was employed by British psychologists more than a generation ago; Spearman, for instance, used it more than thirty five years⁽³⁾ ago. Concerning the creative proceses itself Bruner has observed that any individual in contact with external world is confronted with the masses of data, too much, in fact, for him to handle. What happens is that individual environmental new data seem not as unique occurrences, but as part of related sequence of events which the environment has been previously providing throughout the life. Thus a new datum is rendered meaningful by being connected with past data which it resembles. This process of connection is called "coding" and a set of related data is named "category" Nonetheless, some people, from Bruner point of view.⁽⁴⁾ despite their cultural background retain the capacity to make novel and unusual codings which manifest themselves as creative thinking and more a person treats data which look to have nothing to do with each other as though they

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(1) Jones, T.P. Creative Learning, University of London Press, 1970, P. 5.

(2) Storr, A. The Dynamics of Creation, London, Secker and Warbruy, 1972, P. XI.

(3) Spearman, C., Creative Mind, Cambrilge Univ. Press, 1930&

are related, the more likely he is to make deta combinations which are unusual (i.e. think creatively). This means that willingness to treat data whose connection with each other is not immediately apparent as equivalent would be precisily favourable to the appearance of creativity. Hence creative thinking looks to be related to the width of categorizing and creative thinkers are markedly broader in the width of their categories, so that they are able to see data equivalence which are not at all apparent to more convergent individuals.

Mednick⁽⁵⁾ has advanced an idea of creativity which is of associative sort. He defines creativity as involving the formation of association between stimuli and responses which are characterized by the fact that elements linked together are not normally associative. Thus he suggests that divergent people tend to link atimulus with highly unlikely response, whereas in most people any particular stimulus is usually linked with the response which it has most frequently been paired in the past. Koestler coined the term "Bisociation" for what to him is the essence of the process of creation, meaning by that term the bringing together of two unrelated phenomena. Thus creativity is a process of reorganizing familiar facts into relationships so that new results emerge easily and effectivily; it is wrenching away an object or idea from its familiar context and viewing it in an entirely new one or perceiving a familiar object in the light of new connections.

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(4) **Bruner, J. S., "The Development of Equivalence Transformation in Children" in Wright, J. C., editor, Basic Cognitive Processes in Childre, 1963.**

(5) **Mednick, S. A., "The Associative Basis of Creativity, Psychological Review, Vol. 69, 1962, pp. 220—232.**

It is, for instance, as Koestler put it, seeing the fall of an apple not in connection with its ripeness, but with the interconnections of the motions of the sun, the earth and the moon."[6]

A question is often asked about creativity whether or not it is the same thing as intelligence. In other words, is there a separete "factor" in human intelligence to which we apply the term "creativity"? Are "intelligence" and "creativity" really two distinct traits or would the concept of intelligence considered a unitary trait containing the creativity phenomenon within its folds? Is there an aspect of cognition which can be appropriately labled "creativity" that stands apart from the traditional concept of intelligence? Available researches have still not given a clear and decisive answer to such questions. However, speaking in general terms, American investigators have tended to maintain that intelligence and creativity are two distinct "abilities". Moreover, they have their own interpretation even of the term "gifted child" which has become synonymous, in England, with the expression "the child with a high I.Q." The American Association for the Glfted Children some time ago. agrued that other qualities than I. Q. be included in the conception of giftedness, and defined the gifted individual as a person whose performance in any line of socially useful endeavour is consistently superior. This definition includes those talented in art, music, drama and mathematics, as well as those who possess mechanical and social skills and those with high abstract verbal intelligence. Using the factor analysis, Guilford, the former President of the American Psychological Associa-

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(6) Koestler, A., The Act of Creation, London, Hutchinson, 1964.

tion, has isolated 120 separate, measurable abilities. Present intelligence tests measure six or eight of these abilities. By 1962 Guilford was able to operationally specify 61 of the total 120.(7) Especially useful in clarifying creativity has been the distinction Guilford(8) has mode between abilities for divergent thinking and abilities for convergent thinking. Divergent thinking moves away from responses already known and expected. Convergent thinking moves towards responses that fit to the known and specified. Traditional measures of intelligence empasize convergent thinking. Measures of creativity call for new ideas, an original or unconditional response, and breaking away from the beaten path.

There is the traditional belief that creativity – commonly called "genius" – is hereditary and that nothing could be done to make any person creative: he is either born with the "divine spark" of genius or he is not. Only few people are believed to have the ability to create. This belief has been backed up by evidence of the relativity small number of truly creative products, whether in art, literature or science, that attract widespread attention. Consequently, all people fall roughly into two major groups: the "conformers" and the "creators". The "conformers" do what is expected of them withiut disturbing or causing trouble for others from the intellectual stand point . By contrast, the creators contribute original ideas, different point of view or a new way of looking at a problem and attacking it; they do not follow the beaten path and are sometimes a disturbing element in the intellectual atmosphere: Thus, this notion suggests that a child is either a creative person or noncreative person: he is a confomer all the way or a creator. This notion is, in other words, admits no variation in the degree of creativity one may possess. While the messurement of creativity is still in its infancy, owing mainly to difficulty of devising ways to measure it accurately, there is enough evidence from observation and from the simple measurements now available (in the united States) to show that this notion is not true. Children can no more validly be divided into two major groups in terms of creativity: they possess varying degrees of creativity in the same field as well as in different fields of arts and sciences. In other words, this means that, while a child may be predominantly a "conformer", he also has some creative ability and vice versa.

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(7) Taylor, C.W., Scientific Creativity, New York, Wiley, 1963.

(8) Personality, New York, McGraw-Hill. 1959.

Creativity is difficult to study objectively and even more difficult to measure. The term "creativity" is one of the most ambiguous and, hence, most loosely used term in psychological research today. It is even more ambiguous and more loosely used in the vocabulary of the layman. However, creativity must be regarded as a process – a process by which something new, either an idea or an object in a new form or arrangement, is produced: the emphasis on the act of producing rather than on the end result of this act – which is, of course is included in the process itself as its culmination – is accepted today as central to the concept of creativity. On the other hand, what is created is always new and different from what already existed and, therefore, is unique. However, uniqueness is a personal achievement, not necessarily a universal achievement: a person can be creative when he produces something he has never produced before, although it may have been produced in almost the same form, or even in an identical form by someone else. In other words, creativity involves a specific kind of thinking labeled by Guilford as "divergent thinking". According to Guilford, "divergent thinking" makes excursions from the beaten track and seeks variety. It goes beyond the obvious and apparent, considering several possible answers to a problem, not one single correct solution. This contrasts with "convergent thinking" which follows the conventional path with the thinker using information at hands to arrive at a conclusion that leads to one right answer, one answer similar to that which others would reach.⁽¹⁾ This means that the creative person is more flexible and fluid than the convergent thinker and does not confine himself to the information at hand. This permits a richer flow of ideas and, as a result, it opens up a way toward solutions that are novel and, hence, creative. Another charcteristic of divergent thinking – the kind that is creative – is that it makes leaps: it does not proceed in easily observable and definable phases as is true of convergent thinking which is sequential: proceeds one step at a time.

J. P. Guilford, who had directed the Air Corps research on the selection of combat crews, may fairly be said to have launched much of the effort concerning creativity in the United States with his address as retiring President of the American Psychological Association in September 1950. In that address he systematically surveyed the gaps in knowledge in the domain of intellectual abilities and listed dozens of new

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(1) (a) Guilford, J.P. : Creativity: Yesterday, Today, and Tomorrow: Jaurnal of Creative Behavior, 1967, 1, 3—14.

(b) Guilford, J.P. : Intelligence, Creativity and their Educational Implications, San Diego, California, R. R. Knapp, 1968.

tests then being developed by him and his colleagues in the Psychological Laboratory of the University of Southern California.(1) It is of interest to note here that when in 1950 Professor Guilford announced his retirement as President of the American Psychological Association by listing and describing several dozens possible new tests in the general domain of creative thinking, few in the audience of psychologists who sat quietly though what to many seemed a boringly detailed enumeration of untried intellectual tasks realized that what was to be retired was not Professor Guilford but the concept of the I. Q. It was not new that many intellectual abilities were quite specific in the sense that they might be possessed to an outstanding degree by an individual indistinguished for general intellectual power, but not very many had grasped the fact that an entire domain of intellectual abilities of the utmost importance had been excluded from consideration by the builders of standardized tests designed to measure "intellectual quotient", presumably a single comprehensive summary of general intellectual ability. The excluded intellectual abilities were precisely those that are important in the production of new ideas, or broadly speaking, in paychic creation. What Guilford was proposing was that a full picture of the structure of intellect required a comprehensive study of many abilities for which useful tests did not then exist; he suggested that psychology as a scientific discipline needed to multipy instruments of observation in the area of intellectual abilities in order to study the factorial composition of intelligence and hence to begin differentiating the structure of intellect. Since from the first it had appeared to him that creative thinking abilities were largely untapped in current intelligence tests, he offered ideas for the construction of such tests. Moreover, Guilford and his associates in the project on Aptitudes of High-Level Personal University of Southern Calif. went on from the construction of new tests to the study of their relationship to well known "marker" tests for established factors in intellectual functioning. By subjecating to factor analysis a matrix of interconnections of some 54 test measures covering 8 abilities hypothesized as being important in creative thinking, they succeeded in identifying 7 creative factors in addition to 7 already established and expected factors in perception and congnition in general. The 7 creativity factors were named as follows: associational fluency, ideational fluency, originality, adoptive flexibility, spontaneous flexibility, redefinition and sensitivity to problems.

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(1) A welcome contribution from another source was the clinically ariented studies of Ann Roe, who brought a depth-psychological approach to the study of imagery and motivation in crestive artists and scientists. By the time of Guilford's 1950 address, Roe had already begun her pioner researches in the study of scientific creativity that resulted in her 1952 book: *The Making of a Scientists.*

Guilford point of view concerning creativity is an integral part of his theory of what he calls "the structure of inllect" which was elaborated in its final form in his new book: *The Nature of Human Intelligence* (New York, McGraw-Hill, 1971). The essence of this theory is the factor – analytic approach. "Of course some standard types of modals in human thinking, have been applied in connection with the factor – analytic approach to the investigation and theory of intelligence .... A number of modals have been proposed to provide organized systems of the many intellectual and other factors that have been found by investigators. Burt and Vernon have proposed hierarchical modal, with Spearman's at the top.... The writer's structure – of – intellect modal was presented, with reasons for the need of a morphological type of modal, particularly to take care of obvious parallels that occur between series of factors.(1)".

Guilford has suggested, in 1959, that there are about fifty known factors of intellect, and there are may be many more as yet unknown. For analytic purposes, however, in order to make the various factors more manageable, the American investigators think it is possible to begin by identify two basic cognitive or intellective modes. The one mode tends twords retaining the known, learning the predetermined, and conserving what is. The second mode, as shall see later, tends toward envisaging the unknown, exploring the undetermined, and constructing what might be. A person for whom the first mode or process is primary tends toward the usual and expected. A person for whom the second mode is primary tends toward the novel and speculative. The first favours certainty, the other risk. Various terms have been used to describe the two processes. Guilford has suggested, as already stated, convergent thinking and divergent thinking. Whatever terms are used, it is clear that one process represents intellectural acquisitivenes and conformity, the other intellectual inventiveness and innovation. One focuses on knowing what is already discovered, the other focuses on discovering what is yet to be known. The ability of the first is manifested, through intelligence tests which require that the subject know the common association to a stimulus and the accepted solution to a problem. In many of these tests the subject must respond to a stimulus for which only one answer is correct. He is not asked to innovate, to speculate, to invent. Indeed, if the answer is novel it is likely to be scored wrong. In short, the convential I. Q. tests tend toward the evaluation of those cognitive processes that have been called convergent, retentive, conservative more than those processes that have been called divergent, innovative, and constructive.

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(1) **Guilford, J.P., The Nature of Human Intelligence, New York, McGraw-**

Baron(1) summarizes the findings of current research about the vexed question of the relation between intelligence and creativity in these words: "For certain intrinsically creative activities a specific minimum of I.Q. is probably necessary to engage in the activity at all, but beyond that minimum, which is often surprsingly shown, creativity has little correlation with the scores on I.Q. tests." In recent years it has been fashionable to dissociate intelligence and creativity to the point where one might suppose that possession of high I.Q. was a bar to originality. This notion sprang from the distinction, originally propose by Gotzels and Jackson,(2) between children who possessed high creativity and low intelligence, and children who exhibited high intelligence and low creativity.

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(1) **Baron, F., Creative Person and Creative Process, London, Holt, Rinehart and Wenston, 1969, P. 42.**

During the last decade or so, after the first Soviet statellite was launched in 1957, there had been a great increase both in theoretical speculation and in empirical work in general area of the creative process particularily in the United States. A great flood of books and articles appeared on the topic. Currently the literature on creativity is scattered throughout a great variety of sources, including uppublished material. There is no single review to which the researcher can turn for a comprehensive statement. Therefore, it would be presumpuous to attempt to a fully comprehensive survey of all that mass of material in these pages. Hence, reference will be made to a useful, succinct experimental works carried on by Getzels and Jackson, referred to, on the one hand, and by Torrence,(3) on the other.

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(2) See Taylor, C. W., editor, Scientific Creativity, New York, Wiley, 1963, PP. 161—172.

(3) See Vernon, P. E. editor, Creativity, London, Penguin, 1973, PP. 356—370.

The work of Torrance was conducted in a period of three years at the University of Minnesota Laboratory Elementary School. He differentiated the highly creative children (as identified by his own tests of creativity) from the high intelligent (as identified by stanford Benet, an individually administrated test). The high creative group ranked in the upper 20 percent on creative thinking but not on intelligence. High intelligent group ranked in the upper 20 persent on intelligence but not on creativity. Those who were in the upper 20 percent on both messures were eliminated but the overlap was small. In fact, if Torrence and his co-workers were to identify children as gifted on the basis of intelligence test, they would eliminate from consideration approximately 70 percent of the most creative. Their results have been duplicated in other places, for instance Minneapolis Public High School, the University of Minnesota High School. Getzels and Jackson had earlier obtained the same results in a private secondary school in Chicago;

they found four different categories:

High creativity – Low intelligence.

Low creativity – High intelligence.

Low creativity – Low Intelligence.

However, the research of Getzels and Jackson was criticised as not being authentic because of inadequate procedure and the small number of children used, and that many of the instruments employed were specific and unstandardized. In other words, their findings deservedly attracted a great deal of interest and aroused sharp controversy, Some investigators criticized them quite severely as being ill – designed and inadequately reported. Often Getzels and Jackson appear only to be reporting what favours their own viewpoint and to be omitting crucial information such as the characteristics of the children who scored highly in both intelligence and creativity. Their statistical treatment is so skatchy as sometimes to be positivsly misleading. Even granted that all findings were perfectly accurate and fully reported, one would have to be very careful about attempting to generalized from the very exceptional small groups to children outside this range. Moreover, there have also been several attempts to repeat their work, but with more typical and representative groups of children; these have produced conffiicting results.

The convential intelligence test is familiar: it contains a set of questions in the forms of puzzles, and the subject is asked to find the right answer to each question; sometimes he is to choose the right answer of a list of alternatives. His thinking is said to converge on the right answer. Intelligence test, then, measures convergent thinking: thinking that is shared by others. Creative thinking is different. Considerable, research has recently been done on creative thinking, and out of it have come several batteries of tests designated to measure creativity. Among these tests are Minnesotat tests of creative thinking, each of which contains several questions such as to give as many difinitions as possible of common words or to think of as many possible uses of a common object. Here the individual is asked to diverge, to think fluently and uniquely. There are several thousands of possible uses for a common object such as a chair, a brick, a news paper, and definitely individuals differ widely both in the quantity and the quality of uses they suggest. The uniqueness of the reply indicates its creativity.

All of what has been said is a convincing evidence of the importance of revealing the creative process in children in order to take all possible measures leading to its cullivation. It is of a historical significance to note that the keen interest of the American Psychologists and educationists in discovering and developing the creative process in school children has begum after 1957 and its specific and identifiable point of focus is the success of the Soviet scientists in launching the first sputnik. This scientific event compelled the American investigators to look, with anxiety, at their educational system and recruitment of scientists and technologists. The only device which orthodox mental tests could offer at that stage, and as one aid to selection, was the I.Q. tests – and this failed to distinguish, either before or after the event. those scientists who were capable of original work from those who were not. "The most urgent reason," for the creativity movement in the United States, says Guilford,(1) the well known psychologist, in 1959," is that we are in mortal struggle for the survival of our way of life, in the world. The military aspect of this struggle, with its race to development of weapons and new stratigies, has called for stepped-up rate of invention. Having reached a state of balance with respect to military preparedness we encounter challenges on the intellectual front, a scientific and cultural. Again and again, we have been shaken out of our lethargy and our complicency by new development." It is really sad to find an eminent psychologist as Professor Guilford, the former President of the American Psychological Association, formulate his perspectives in a negative and destructive tone rather than otherwise. It is strange that he regards the scientific conquest of the outer space as the threat to the American way of life....

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(1) Quoted By Vernon, P.E., Creativity, London, Penguin, 1973, P., 167.

It was the Soviet first sputnik, then, that spurred the American to analyze the development and status of the educational system in the Soviet Union, the decade of 1960's was marked by an accelarated appearance of various types of work on Soviet education. The general tendency tends to praise that educational system, but to discredit the Soviet socialist system of which the educational system is an integral part or the consequent product. In other words, the authors of these books try to isolate the Soviet educational system from its social context and, moreover, to distort the essence of the Soviet political system and present it with an ugly face so that the readers will disgust it. On the other hand, they make many suggestions to reconstruct their educational system within the framework of the existing political system of their country.

It is, let me repeat again, the advant of Sputnik in 1957 that shaked the United States into asking whether its educational system was failing to produce sufficient creative scientists to maintain its technical lead in the Western world. In other words, Sputnik catalized the realization for Americans that further development would depend on having many creative men at work in a constant effort to transcend what had already been done with accomplish ments still more novel and powerful. Hence, tremendous research on creativity became legitimized as a properly serious concern of the military, government and industry. One such vehicle of central importance has been the series of conferences organized by Calvin W. Taylor of the University of Uta. Five of these conferences (1957, 7959, 1961, 1962, 1964) were focused primarily on problems connected with identifying creative talent for the sciences and the use of educational media as a means for creative education. All of them were supported by the National Science Foundation and the U.S. Office of Education.

It would be impossible to summarise all work that has been done in recent years on creativity. However, a useful survey of empirical research is provided by Freeman and others.⁽²⁾ An attempt to provide a single, critical, integral view has been made by Taylor.⁽³⁾ Taylor has also edited the proceedings of the Utah Creativity Research Conferencess.⁽⁴⁾ Anderson has performed a similar service for a symposium held at Michigan State University.⁽⁵⁾.

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(1) Parnes, S. J., editor, Compendium of Research on Creative Imagination, Creative Education Foundation, Buffalo, New York, 1958.

(2) Freeman, J., Butcher, H.J., and Christie, T., Creativity: A Selective Review of Research, London, 1968.

(3) Taylor, C.W., editor, Creativity: Progress and Potential, London, 1964.

(4) Taylor, C.W., editor, Widening Horizons in Creativity: The Proceedings of the Fifth Utah Creativity Research Confernece, London, 1964.

(5) Taylor, C.W. and Williams, F.E., editors, Instructional Media and Creativity: The Proceedings of the Sixth Utah Creativity Research Conference, London, 1966.

In the summer of 1958, the newly founded creative Education Foundation Published the first *Compendium of Research on Creative Imagination,*"(1)" concering thirty research studies concerned with the indentification and development of creative ability. This comprised all recent studies in the field at that time. Then(within approximately eighteen months) thirty new research studies were reported and summarized in a second *Compendium.* This also listed twenty-eight additional research projects that had just been started-about double the number apparently under way where the first *Compendium* was compiled. At the 1959 University of Uta Research Conference on the Identification of Creative Scientific Talent, a committee was appointed for the first time to report on the role of educational experience in the development of creative scientific talent. In the same vein, Irving Mattzman and his associates at the University of California concluded, in 1959, a group of research studies on creativity training. And the Univ. of Chicago has conducted several research projects on the effects of teaching creative problem-solving to governmental and industrial administrators in 1960.

It has alreary been mentioned that since 1957 there appeared in the United States many books dealing with the education in the Soviet Union and their general trend was to praise that education but to discredit the Soviet socialist system. The followings are typical instances. "The many scientific and technological developments in the Soviet Union", said Rosen, "undoubtedly stimulated a revival of world interest in education in the Soviet Russia..... The USSR would score high in scientific achievements and development of heavy industry, the tools of state and military power. It would rate low in concern for the individual." And again: "However well organized the children's activities, however well equipped the circles, however beautifully excuted and illustrated the children's books, however well produced and well acted play, the all-prevailing influence of the official ideology is inescapable and produces an impression of unbroken monotony. The whole of the Soviet cultural life is indeed like the narrow corridor.... that leads straight to one exist only." Seventy members of the American Comparative Education Society spent a month in the summer of 1958 in the Soviet Union and Published a volume of more than 500 pages concerning education in the Soviet Union. This is what they say at the first page of their book:" An enigma inside a riddle wrapped in a mystery". This was the description Winston Chuchill applied to the Soviet Union... Later he referred to it as the iron-curtin country... Education in the USSR, it is clear, is used as a tool to futher the Soviet goals. Education in a free society does not operate in the Soviet maner which is so contrary to the objectives our people and nation have for their schools... Our emphasis since the origin of the first school here, is on freedom and individual initiative". (2) In 1959 the American Psychological Association asked several investigators to assess Soviet work in the field of child education under grants from the National Science Foundation, the Committee On Soviet studies of Cornell University and the Russell Sage Foundation. The following remarks are taken from their report: "From the very beginning stress is placed on teaching children to share and engage in joint activity... collective play is emphasized. Not only group games, but special complex toys are designed which require the cooperation of two or three children to make them work... We believe that the results of this inquiry indicate that rather different approach to the upbringing of the young is not without significance for our problems. The Russians have gone for in subjucating the child and his peer group to conformity to a single set of values imposed by the adult society". (3)

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(1) Rosen, S.M., Education & Modenization in the USA California, Addison, 1971, PP. XVI—4.

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(2) Bereday, G.Z.F. and Others, The Changing Soviet School, Boston, Houghton Mifflin, 1960, PP. VII—VIII.

The United States Educational Mission to the Soviet Union, which spent several weeks in the USSR in 1958 aid in its Official Report.(4) "But we do emphesize that, whether we like it or not, competition has been imposed upon us by a nation of vast resources, a people of seemingly unbounded enthusiasm for self-development, governed by a ruling hierarchy which is determined to cast about the shadow of communist domination... We came back deeply concerned about our poorer schools now suffering from neglect... The one fact that most impressed us in the USSR was the extent to which the nation is committed to education as means of national advancement... Tremendous responsibilities are placed on Soviet schools, and comprehensive support is provided for them by all segments and agencies of Soviet Society. There seems to be complete equality between men and women. The relationship between boys and girls in school appears to be characterized by dignity and mutual respect for each other. At each desk there is usually one boy and one girl". Although the remarks in this passage concerning the place of education in the Soviet Union are sincere reflection of social reality, but the allegation that the Soviet people are "governed by a ruling hierarchy..." distorts the whole picture of the Soviet Union. Moreover, it is really ridiculous that a group of American educators, who know better than any one else, the true rulers of the United Sates, try deliberately to violet all principles of objectivity.

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(3) Bronfen-brenner, U., Two worlds of Children, New York, Russell Sage Foundation, 1970, PP. 165—166.

(4) Soviet Commitment of Education, New York, Greenwood, 1959, pp. XI—2.

It is of historical interest to quote from what has John Dewey said about the Soviet Union and its educational system half a century ago, when he visited the country in 1928 as a member of a delegation of twenty-five educators and wrote a series of articles for the New Republic in November and December, 1928, which were reprinted the following year.(5) Dewey felt that "the Russian educational situation is enough to covert one to the idea that *only in a society based upon the cooperative principles* can the ideal of educational reformers be adequately carried into operation". (6) He found that the Soviet school children were "much more *democratically* organized than are ours." and that they receive "through the system of education a training that fits them, much more systematically, than is attempted in our *professedly* democratic country, for latter active participation in the self direction of both local comm-

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(5) Impressions of Soviet Russia, New York, New Republic, 1928.

(6) Ibid., P., 86 my italics.

unities and industries". (7) Dewey admiration for Soviet educational progress made him "deeply regret those artificial bariers and barefaced of false reports that now isolate. American teachers from that *educational system in which our professed progressive democratic ideas are most COMPLETELY* embodied. and from which accordingly we might, if we could, learn much more than from the system of any other country". (8)

In almost all statements made in recent years by psychologists, educators and public fegures in the United States and in the United Kingdom concerning the future of the coming generation there has been a sincere call for a change of the existing school system. In the field of teaching it is said that the main trend is to produce conformists, stereotyped, parrot-like students rather than creative human beings. Teachers, especially in the primary schools, are frequently described as being very narrow-minded and careless in their attitudes toward creativity which manifests itself constantly in front of their eyes during their daily classroom work. Recent and ongoing studies show convincingly that every school subject, even traditional ones, can be taught creatively. Even in leisure time, say the critics, that is the activity goes inside the school and in communty, the passive enterainment and group stereotyped actions are overwhelmingly predominant; in the field of science and technology, too, there is a mass production on a large scale of scientists and technicians, but

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(7) Ibid., P.P. 105—106. italics mine.

(8) Ibid., P.P. 107—108. italics not in origin.,

the number of those who can creatively formulate fruitful hypatheses or theories is very small indeed. It is even claimed that to be original or different is often to be dangerous.

Those criticisms have aroused a considerable popular concern and endeavour regarding the training of students for increased creativity both in England and in the United States, and a large number of new courses have been instituted, especially, in the United States, some of them being in Universities, some in industry and some in governmental agencies. Traditional methods of teaching have been, likewise, modified to a large extent and new ones, such as the "brain storming" method, are introduced. Brainstorming in all seriousness has been taught in recent years most notably by Sidney J. Parnes, whose article "So You Really Understand Brainstorming?" (1962) is refreshing and clarifying. He points out that brainstorming is essentially part of a total process; creative problem solving is the whole; brainstorming is an element that is usually present whether one sets it up deliberately or not. The basic property of the brainstorm is the out pouring of ideas without evalution while the storm is on. A course named "creative problem solving" was initiated in the University of Buffalo several years ago. The University of Chicago has conducted several research projects on the effects of teaching "creative problem-solving" to governmental and industrial administrators. At the University of

Buffalo, the principles of creative thinking were taught in the elective one short course and have also been used in special programmes for groupings of students in engineering, law, humanities, physics, mathematics and psychology. Similar courses and programmes patterned after those of the University of Buffalo have been wide spread in the educational institutions in all parts of the United States: in industrial organization and in governmental bodies.

The theoretical principles behind all of this is that although there is still little knowledge about the nature of the creative process at the present time, the American investigators affirm that they do know for sure how to stimulate it, and that the most urgent task of education at the present time is to help every student to release whatever creative potential he possesses to its utmost capacity. The creativity of the student is frequently so inhibited unintentionally, in their opinion, by his social and educational circumstances that he becomes unable even to recoginze it in his daily school work. Once he could be helped to be aware of his creative potentialities, he may easily attain what is abtly described as self-acqualization. Education can do much to help every individual to achieve his fullest self-realization whatever the level of his native abilities. All people possess the seeds of creativity to certain extent, but the social environment, and the educational in particular, does not provide the proper norishment for their fruitful maturation. It is interesting to note here the role of the play in this respect.

Wallach and Kegan,(1) for instance, quoting Einstein as referring to the need for combinatory play and association in putting ideas together. Drydom, they say, describes play in putting ideas together. Drydon, they say, describes the process of writing as involving a confused mass of thought trumbling one over another in the dark, and Poincare talked about ideas having rose in crowds immediately prior to his obtaining a significant mathematical insight. Creativity awarencess, they maintain, tends to occur when the individual is in a playful manner-entertaining a vast range of possibilities without warry about his own immediate triumph or failure. Taking their theoretical departure from this principle, Wallach and Kegan, administered a research programme involving an extensive study of 151 children in the fifth grade. Their general objective was, first, to study the flow of ideas in each child concerning the uniqueness of these ideas, their abundance and their relevance to the various kinds of questions; and, second, to provide an educational atmosphere similar in nature to that of play rather than a formal one in which the child feels that he is under the psychological strain of the test and the inspection of teachers. Wallach and Kegan employed all possible means to put the assessment procudures in a context of play rather than in the familar context: there were no time limits on the procedures and they were administered individually, not to various groups of children seated at their usual classroom desks. The procedures involved, for instance, such matters as asking the child to mention all possible uses of familiar objects such as a chair, a newspa-

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(1) See: Hunt, J.M., editor, Human Intelligence, New Jersey, Dulton, 1970, PP. 167—169.

per, a shoe or to describe all possible ways in which each of several pairs of familiar objects resemble each other such as a potato and a carrot, a cat and mouse, milk and meat. "Rip it up if angy". was, for example, a unique response, in their opinion, for a newspaper, while "made a paper hat" was not unique. "They are government inspected" was a unique response for "milk" and "meat" while "they came from animal" was not unique. This indicates, from their standpoint, that a certain child reveals himself in the number of relevant ideas he advances, and in the suggested ideas: the uniquencess of the child's response to a given question is that it belongs exclusively to him and not was suggested by others as well. This implies that creativity tests consist of two main types of question. Words association type and uses for things type. In the first type the subject is asked to give as many definitions as possible to fairly common stimulus words. His score depends on the absolute number of definitions could be put. In the second type the subject is required to give as many uses as he could for objects that customerily have a stereotyped function attached to them. His score depends on the number and originality of the uses he mentions. A student obtaining a low score on the creative tests might reply to the object "brick", for example, by saying that it can be used for building purposes. A student obtaining a high score might say to the same item: "you can use it as a paperweight or doorstep or a bed warmer or throw it as weapon or hollow out the centre of it and make an ash tray.

That is in the United States. In the United Kingdom, the education of creative children (the gifted as they are described is still in its infacy and is done by voluntary bodies outside the state educational system. This has led, in one way or another, to the criticism coming from various sources of the school system for its negligence of creativity. Bridges, for instance, who is a member of the school council of the Working Party concerned with the methods of helping intellectually gifted children to grow into an integral well-balanced adults, describes the existing English system of education in these words: "There are, of course, many points in the system which require radical revisions, many attitudes which are in need of reappraisal, but certainly one of the most important is the realization of the existence of creative potential as a factor which is not necessarily synonymous with intelligence as it is traditionally measured. Too long we have rewarded convergent intelligence at the expense of divergent intelligence. Our truly creative individuals have emerged inspite of, or rather than as a result of, the education they have to receive, and this is true of creative engineers and scientists as of practitioners in the arts". (1) The official sources, on the other hand, speak differently. The Plowden Report, already referred to, says these words concerning this educational issue: "The majority of us believe that the English system of primary education at its best is better adapted than any other we have seen(2) to provide for the needs of the gifted individual, without segregating him". (3) This indicates that the education of the gifted is already taken care of within the existing state system and that other delibrate efforts can be taken by voluntary associations notably National Association for the Gifted Children (N A G C which was founded in 1965). The main functions of this Association are to help gifted children develop their abilities and to give advice to parents and teachers in this respect. Its educational measures are numerous and are taken in its head quarter in London as well as in its local branches. Among these measures is the annual conference which brings together many of the eminent workers in the field as well as many teachers and parents. In certain cases it gives advices to those who approach it and also organize Days for parents as well as for children and Days for particular activities such as music or science.

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(1) Bridges, S.A., Gifted children and Brent-wood Experiment, London, Pitman, 1969, P. 47.

(2) Denmark, France, Pland, Sweeden, USSR and USA. Plowden Report: Children and their Primary School, H.M.S.O., 1967, pp. 531—536.

(3) Ibid, PP. 306—307.

As for the experimental projects concerning gifted children in England, the prior work in this field was that of Brentwood College of Education with the young gifted children from Essex schools coming for half a day each week. This educational experiment is that which was reported by Bridges.(4) The other important experiment is that which was carried by professor Tempest in a primary school and was reported by him.(5)

There are, however, other suggested procedures such as accelaration and enrichment and the establishment of special schools for gifted children. The aim of accelarition is to break up the existing rigidity of classes based on chronological age, and that of enrichment is to occupy the gifted with more difficult educational tesks. The proposal of special schools for gifted children "has not received much support... There is little evidence to justify it, and in any case, it is contrary to the prevailing ideas based on sociological approach to education". (6)

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(4) Bridges, S.A., Gifted Children and the Brentwood Experiment, London, Pitman, 1969.

(5) Tempest, M.R. Teaching Clever Children 7—11, London, Routledge, 1974.

B: Creativity and Insanity.

The notion that creativity (or genius as it is frequently named) is madness or abnormality is an old idea. It goes back to the acient Greek thinkers. "Famous poets, artists and statesmen". says Aristotle frequently suffer from melancholia or madness". The same view was repeated by the French eighteenth-century thinker, Didero, who remarked (as Lombroso sait in his book: The Man of Genius): (8) "I have often thought that these reserved and melancholic men owe their extraordinary, almost God-like acuteness of insight, to a temporary disturbance of their whole mechanism. One may notice that it brings them now sublime and now to insane thought". At the present time several outstanding investingators think likewise, notably Lombroso, who pointed to the organic link between genius and mental disorder; Kretschmer asserts emphatically that "most outstanding movements in the intellectival culture... and politics are born of men who do not possess that feeling of competetness and well-being; that is to say... of men mentally abnormal, neurotic, psychopathetic and mentally diseased ... Genius is gradually bred in a single family life or in a group of related families ... Many geniuses have been unmarried or childless ... Wholesale family decadance occurs with surprising frequency and severity, precisely among the greatest men of genius. Indeed one only refers to families of Goethe, Byron, Beethhoven, Bach, Michelangelo and Feurbach." (9)

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(6) Bridges, op. cit., PP. VI—VII.

(7) Quoted, by Kretschmere, E., The Psychology of Man of Genius, London, Kegan Paul, 1931, PP. 3—4.

Freud, as it is well-known follows the same track, although with a different interpretation; "The artist" he writes "is an insapient introvert who is not far from being neuratic. He is impelled by two powerful instinctive needs. He wants to achieve honor, power, richness, fame and love of women. But he lacks the means of achieving those satisfactions. So like any other unsatisfied person, his libido, too, to the elaboration of his imaginary wishes, all of which might easily point to the way to neurosis ... It is well-known how often artists especially suffer from a partial inhibition of their capacities through neurosis. Apparently their constitutions are strongly endowed with an ability to sublimize and shift suppression determining their conflicts. The artist finds the way back to reality in this way ... He understands how to elaborate his day-dreams so that they lose their essentially personal elements ... He also knows how to disguise them so that they do not easily disclose their origin in their despised sources. He further possesses the puzzling ability of modeling a specific material into a faithful image of the creatures of his imagination, and then he is able to attach to his representation of his unconcious phantasies so much pleasurable gratification that, for a time at least, it is able to outweight and release the suppressions .. He wins gratitudes and admiration for himself and so, by means of his imagination, achieves that very things had at first only an imaginary existence for him." (10) Freud elaborated his psychoanalytic interpretation of creativity, especially in the field of art, in his essay on Leonardo da Vinici. In that essay, completed in 1910, Freud attempts to explain Leonardo's staggering creative energy – as an artist, engineer and scientist – in terms of the infantile sexuality, suggesting that Leonardo's sexual energies were diverted or sublimated in the course of childhood into the systematic exploration of the world surrounding him.

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(9) Ibid, PP. 10—15.

It is of interest to mention in this respect that the noted Soviet geneticist Filphenov, in his recent study of the biographies of famous scientists and scholars, convincingly supports the well-known observation that genuises reveal all sorts of mental anomalies more frequently than ordinary people. True enough eccentricities of genuises catch the eye, or at any rate, we pay greater attention to them than to those of an ordinary mortal. But that it may, one should not ignore the fact that there is some kind of relationship between man's endowments and deviation from the standard in his behaviour. Why do anomalies and genius go together? In attempt to answer this question Krushinsky advanced an interesting notion which says that to enable genetic traits to manifest themselves fully requires certain excitibility. In one of his "Wednesdays" (11) meetings held on January 9, 1935, Pavlov registered the following remarks: "When we analysed nervous patients in the neurological clinic, I came to the conclusion that there are two specifically human neuroses-hysteria and psychasthenia; I related this conclusion to the fact that man offers two types of higher nervous activity, namely, the artistic type, consequently analogous and close to that of animals which also perceive the external world in the form of impressions exclusively and directly by means of receptors; and the other, intellectual type which functions with the help of the second signalling system. Thus, the human brain is composed of the animal brain and of the purely human part relating to speech. It is this second signalling system which is beginning to prevail in man. It can be assumed that under certain unfavourable conditions, when the nervous system is weakened, this phylogenetic division of the brain takes place anew; then probably one individual will use predominontly the first signalling system, while the other will use predominartly the second signalling system. And it is this that divides men into artistic nature and purely intellectual nature. In unfavourable conditions when the divergence attains a high degree, a morbid manifestation of this complexity of the higher human nervous activity takes place in the form, so to speak, exaggerated artists and exaggerated thinkers (pathology). I think the former are related to hysterical persons, and the latter to psychasthenics. I have seen many neurotics. As to the unsuitability for life or inactivity of these patients, it must be said that the psychasthenics are particularly feeble compared with the hysterical persons. This is confirmed by facts. Many hysterical persons become prominent public men ... On the contrary, psychasthenics, who limit themselves exclusively to words, are in most cases unsuitable for life and absolutely helpless. Of course, there are also hysterical individual, whose activity becomes so chaotic that they, cannot find their proper place in life, and who are nuisance both to themselves and others." (1)

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(10) **Quoted By Vernon, P.E., editor, Creativity, London Penguin, 1973, P.P. 135—136. Arecent stemulating critical evaluation of Ereud's point of view appears in: Storr, A., The Dynamics of Creation, London, Secker and Warbudg, 1973, P.P. 1—40.**

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(11) **Pavlov's famous/Wednesdays began in 1921 when, after the victorious termenation of the civil was the Soviet country embarked on the path of peaceful and creative work aimed at building the new, socialist society. Twice weekly (on Wednesdays and Fridays) Pavlov held the meetings in the physiological laboratory of the Russian Academy of Sciences which he headed. Taking part in the usual experiments, he at the same time acuainted his coworkers with results of research carried out in other laboratories under his charge.**

In his report read at the Second International Neurological Congress, London, August, 1935, Pavlov said: "Hysteria is the rtsult of general weakness in the artistic type; psychesthenia ... is a product of weakness in the thinking type ... Hysteria has to do with a general weakness especially of the second signalling system, which, in the artistic type, is normally subservient to the first signalling system, while in the average person the second signalling system is the highest regulator of human behaviour. Hence the chaotic condition of the activity of the first signalling system and of the emotional background occurs in the form of fantasies with unrestrained motivation and a profound disturbance of the general nervous equilibrium ... and the consequent chaos in the synthesis of personality. In the psychasthenic the general weakness is also in the relationship of the organism to the environment, but in the first signalling system on the basis of the emotions; therefore, the lack of reality feelings, the complete incapability and uselessness, the ideas of compulsion, phobia, and the constant, distorted melanchaloy." (2) Pavlov concluded his inquiry in these remarks "I put to myself this question, and what about our animals? the existence of psychasthenics among animals is excluded, since they do not pocess the second signalling system. In the final analysis all complex relations in man have passed into the second signalling system. Verbal and abstract thinking has been elaborated in us. The second signelling system is the most constant and the main regulator of the human relations. But there is nothing of this in animals. Their entire higher nervous activity, with its supreme manifestation, is included in the first signalling system. In man the second signalling system acts on the first signalling system and upon subcortex in two ways: in the first place, by inhibition which is greatly developed in it, and is absent or almost absent in the subcortex (and which, it can be assumed, is less developed in the first signalling system); in the second place, by its positive activity-by the law of induction. Since in man the activity is concentrated in the region of speech-its induction must act on the first signalling system and the subcortex. Such relation, cannot exist in animals. But they can assume this form when the inbibitory process in the first signalling system (which in animals stands above the subcortex) is weak. Since the first signalling system in animals is also the regulator of the subcortex, a relation essentially similar to that in hysterical persons may arise; if the inhibitory process in the first signalling system of the animal is weak, the subcortex falls into a state of violent excitation and its activity does not correspond to the action of external stimuli. Consequently, something analogous to hysteria may also take place in animals. While in man we meet with the pressure of the second signalling system on the first signalling system and on the subcortex, in animal it is the first signalling system which excerts pressure on the subcortex. Essentially this is the same thing, but in the second case there is a single source of inhibition, while in the first case there is a double source (partly the positive system and partly the intense activity). "1"

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(1) Pavlov, I.P. Selected Works, Moscow, Foreign Languages Publishing House, PP. 589—590.

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(2) Pavlov, I.P., Lectures on Conditioned Reflexes, London Lawrence and Wishart, 1941, Vol. II, PP. 162—163.,

In concluding this part of this study one can definitely assert that there is no organic interconnection between genius and insanity: no cause-effect relationships and that when they occur their linkage is coincidental. Not all geniuses are abnormal, and not, of course, every abnormal is genius, Insanity is not an intrinsic artibute of genius, and when it occurs it deteriorates genius as well as personality. On the other hand, it is necessary to make an unbiased selection of cases for study, for the works, of Lombroso, and Krestchmer, for instance, long ago taught us that by sufficientlly biased selection it is possible to "prove" almost any theory regarding "genius" however bizarre. In other words, Lombroso's method of heaping up instances which support his thesis, while omitting mention of those which contradict it, is not convincing; and perhaps even less convincing, though,

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(1) Pavlov, I.P., Selected Works, Moscow, Foreign Languages Publishing House, 1955, PP. 290—291.

more subtle, is his implied extensive of a definition of insanity to include all who show any casual or temporary deviation from an assumed of normality in a given society.

When the British painter Louis Wenn developed the schizophrenic reaction, he painted only cats as long as he lived and never displayed any particular talent. The mental disease destroyed whatever talent he did have, as it ravaged his mind and devastated his personality. Although a disease may fail to destroy a brilliant talent, but this does not mean that talent is a disease.

C: Creativity and "Unconsciousness"

Many famous creative thinkers, espcially in the field of mathematics, claim that proper solutions of difficult problems came to them suddently after they abondoned their conscious efferts which led them no where. The history of human thought is pregnant with such instances, most famous among them are the following interesting episodes: Helmholtz, for instance, the great German physicit, speaking in 1891 at a banquet on his seventeeth hirthday, described the way in which his most important new thoughts came to him. He said after previous investingation of a difficult scientific problem "in all directions ... happy ideas come unexpectedly without effort, like inspiration ... So far as I am concerned, they have never come to me when my mind was fatigued, or when I was at my working table ... they come particularly ready during the slow ascent of wooded hills on a sunny day". (1) Helmholtz here describes three stages in the producing a new idea: the first is what Graham Wallas calls preparation, the second is what he names incubation and the third in which the happy idea appears is illmination."(2) Guass, referring to an arithmetical theorem which he had unsuccssfully tried to prove for years: "Finally, two days ago, I succeeded not on the accunt of my painful efforts, but by the grace of God. Like a suddent flash of lightening". (3) This sudden flash of lightening is as old as Archimedes, and there are many other facinating instances in this field. An appropriate example to qoute here is the simultaneous discovery of the notion of natural selection by both Darwin and Wallace. Darwin wrote "I can remember the very spot on the road, whilst in my carriage, when to my joy the solution occurred to me. "And Wallace wrote" Vaguely thinking over the enormous and constant destruction this implied, it occurred to me to ask the question: Why do some die and some live? and the answer was clearly that on the whole the best fitted live ... Then it suddenly flashed upon me that this self-acting process would improve the race". (4) Poincare stated graphically in his article "Mathematical Creation": "For fifteen days I strove to prove that there could not be any functions like those I had since called Fuchsian functions. I was then very ignorant: every day I seated myself an hour or two at my work table, tried a great number of combinations and reached no results. One evening, contrary to my custom, I drank black coffee and could not sleep. Ideas rose in crowds; I felt them collide until pairs interlocked, so to speak, making a stable combination. By the next mroning I had established the existence of a class of Fuchsian functiona ... I had only to write out the results, which took but a few hours". (5) Then poincare described vividly another interesting instance: "Just at this time I left Caen, where I was then living, to go on to a geologic excursion under the auspices of the school of mines. The changes of travel made me forget my mathematical work. Having reached Coutance, we entered an omnibus to go some place or other. At the moment I put my foot on the step the idea came to me, without anything in my former thoughts seeming to have paved the way for it". (6) And still a third instance: "Then I turned my attention to the study of some arithmatical questions apparently without much success and without a suspicion of any connection with my preeceding researches. Disgusted with my failure, I went to spend a few days at the seaside, and thought of something else. One morning, walking on the bluff, the idea came to me, with just the same characteristics of brevity, suddeness and immediate certainty that the arithmetic transformations of ideterminate dernary quartric forms were identical with those of non-Elicldean geometry". (7) The general conditions reached for all previous instances is this: "Most striking at first is this appearance of sudden illumination, manifest sign of long, unconscious prior work. The role of this unconcious work in mathematical invention appears to me uncontestable, and traces of it is less evident. Often when one works at a hard question, nothing good is accomplished at the first attack. The one takes rest, longer or shorter, and sets down to the work. During first half an hour, as before, nothing is found, and then all of a sudden the decisive ida presents itself to the mind. It might be said that the conscious work has been more fruitful because it has been interrupted at the rest has given back to the mind its force and freshness. But it is more probable that this rest has been filled out with unconscious work and that the result of this work has afterward revealed itself to the geometer just as in that I have cited ... these sudden inspirations (and the examples already sited sufficently prove this) never happen except after some days of voluntary effort which has appeared absolutely fruitless and whence nothing good seems to have come, where the way taken seems totally astray. These efforts then have not been as sterile as one thinks; they have set agoing the unconscious machine and without them it would not have moved and would have produced nothing". (8)

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(1) **Quoted By Wallas, G., The Art of Thought, New York, Onathan Cap, 1926, P., 79.**

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(2) Ibid, P. 73.

(3) Quoted By Hadamard, J., The Psychology of Invention in the Field of Mathematics, New York, Dover, 1954, P., 15.

(4) Quoted By Hudson, L., Originality, Oxford Biological Research, No. 60, 1973, P., 15.

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(5) Poincare, H., Science and Method, New York, Dover, no date, B.P. 81—82.

(6) Ibid., P. 82.

(7) Ibid, P. 83.

Another famous mathematician experience the same phenomenon and reached the same conculsion, this time the American mathematician Hadamard who wrote: "One phenomenon is certain and I can vouch for its absolute certainty: the sudden and immediate appearance of a solution at the very moment of sudden awakening. On being abruptly awakened by an external noise, a solution long searched for appeared to me at once without the slightest instant of reflection on my part and in a quite different direction from any of those which I have previously tried to follow". (9) The same phenoemon has been reported to happen in dreams, and a celebrated example is the following report of Kekule, a famous German chemist. It is of interest to mention here that as late as 1850 the structural arrangements of carbon atom in the hydrocarbons and especially those in benzene, C_6H_6 was unknown. A classical story of how Kekuli's idea of these structural arrangenments came to him in a dream is given by the famous chemist. In a speech given by him before the German Chemical Society, March", 1890, on the occasion of a celebration held in his honour, he described how he happened into these ideas. He said: "During my stay in Ghent, Belguim, I lived in a fine room on the main street I set in this room and wrote on my textbook, but could made no progress – my mind was on other things. I turned my chair to the fire and sank into doze. Again the atoms were before my eyes. Little groups kept modestly in the background. My mental eye, trained by observation of similar forms, could not distinguish more complex structures of various kinds, long chains here and there more freely joined; all winding and turning with snake. – like motion. Suddenly one of the serpents, caught its own tail and the ring thus formed whirled exasperatingly before my eyes. As if by a fiash of lightning I awoke". (10) Kekule thus solved the chemical problem of the benzene molecules using rather than a chain of carbon atoms.

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(8) Ibid, P. 84.

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(9) Hadamard, J., The Psychology of Invention in the Field of Mathematics, New York, Dover, 1954, P. 80.

(10) Quoted By Garratt, A.B., The Flash of Genius, New York, Nostrand, 1963, P. 185.

Recently Loewi, who was awarded the Nobel Prize some years ago for proving that active chemicals are involved in the action of nerves, related the story of his discovery by saying that his experiments on the control of a beating frog heart were given puzzling results and that he warried over them. During his sleep one night he saw a wild possibility and the experiment which could test it. He awoke and scribbled some notes and slept again peacefully till morning. The next day was agony – he could not read the scrowl nor recall the solution, though remembering that he had had it. In the next night lightning flashed again and he took no chances this time but went to the laboratory at once and started his experiment. A mathematical dream was related by Dockson, a famous American mothematician: his mother and her sister, who at school, were rivals in geometry, had spent a long and futile evening over a certain problem. During the night, his mother dreamed of it and began developing the solution in a loud and clear voice; her sister, hearing that, arose and took notes. On the following morning in class, she happened to have the right solution which Dickson's mother failed to know.

It is of interest to mention here that an earliest psychologist(11) was among the first to offer the theory of "Unconsious cerebration" occurring during the intervals of rest. He had gathered many instances for inventors, artists, and poets of their laying a problem aside and finding that after sleep or recreation just what they wanted came into their heads. A recent researcher quoted a variety of occasions for the occurrences of original ideas to investigators, "Sunday in church as the preacher was announcing the text" or " in the morning when shaving" or "while resing and loafing on the beach" and so on.(12)

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(11) Carpenter, W.B., Principles of Mental Physiology, New York, Appleton, 1876.

Kohler,(13) who is famous for his experimental work on the mentality of apes, has established the following criteria of intelligent behaviour: "Suddenness dis-covery of solution" and claimed that intelligent animals discover right solutions for the complicated problems confronting them suddenly, generally after several fruitless trials; and even their fruitless attempts, however, are not usually the hit - and - miss affairs of unmtelligent animals - the intelligent animal does not keep repeating its mistakes. In its most general form Kohler formulated the investigation used by him as follows: the experiment gives rise to a situation in which the direct path to the goal is barred, but in which an indirect path remains. A further complication of the same principle consists in introducing tools into the experimental situation. The circuitous route to the goal is formed, not by the movements of the animals own body, but by the aid of external objects which play the part of tools. Where the movements of the organs are replaced by movements of the tools and become mediated, we are confronted with an intelledual operation on the part of the animal. At the same time we have a very important criterion of intelligence behaviour, viz. the use of tools. This purposive application of tools in accordance with the character of the situation is an objective indicator of the intelligent reactiin of animal, for the employment of tools presupposes an understanding of the objective properties of things.

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(12) Haefele, J.W., Creativity & Innovation, New York, Reinhald, 1962.

(13) The Mentality of Apes, New York, Harcourt, 1925.

It is well-known that in the course of his famous experimental work on chimpanzees (Teneriff, 1914—1920), Kohler confronted his animals with four types of problems: First, detour problems – an obstacle is placed between the hungry animal and its food, which the animal can only reach by going round the obstacle, or else the food is out of direct reach and must be hauled in by means of an attached string or other intermediate objects. Second, problems involving the removal of obstacles (the converse of the first): a box or some such object is interposed between the animal and its food and must be pushed out of the way. Third, problems involving the use of impliments. The food is placed outside the cage and sticks, planks, boxes, ect. are provided for hauling in the food, or for knocking it down. Fourth, problems involving the simple construction of implements from elements which, by them – selves, are inadequate for coping with the situation.

In concluding this part of this study it is important to stress that all creative scientists as we shall see later, are unusually hardworking to the extent of appearing almost obssessed of the work. The common characteristic of all of them is to have without exception an intense devotion to their work. Newton is reported to have been asked how he had discovered his laws of gavitation and to have answered: By constantly thinking them over. Even those, who asribed their creativity to the working of the "Unconscious" during their awakening or sleep, their attention was, in fact, concentrated on their scientific problems. It is an established fact, in the light of Pavlovian physiology, that even under conditions of complete waking, the irritable state of some cells of the cerebral cortex is always connected with the inhibitary state of others. The individual sections of the cerebral cortex in any particular state constitute a complex movable moasic, these small sections of inhibition creating a mobile local breaking-up sleep. According to Pavlov's theory, sleep inhibition may be partial in depth and extensiveness and develop in restricted section of the cerebral cortex. One part of the cerebral cortex may be in a waking state and the other in a state of sleep inhibition, for example, during the transition from the waking state to sleep. The waking section of the cerbral cortex constitutes what Pavlov named the sentry post. Being positively induced, under the influence of the inhibitory state of the surrounding sections of the cerebral cortex this sentry post is in the state of increased excitibility: "under the influence of the onslaught of inhibition" according to Pavlov expression,(1) which ensures the maintainance of its connection with the external world.

This offers a physiological substantiation of many other facts, in addition to solving mathematical or chemical problems during sleep as was mentioned previously, which were explained metaphysically as the working of the so-called "Unconseious". We know, for example, that a tired mother fast asleep at the bed beside the bed of her sick child and indifferent even to loud sound stimuli, easily awaken from the slightest sound produced by her child. A miller who sleeps peacefully during the normal noise of his running mill awakens the moment the mill begins to run idle – the change noise of the mill wheels is a signal for the awaking sentry post of his cerebral cortex about the necessity of charing the mill with a new portion of grain. A person who went to sleep in the evening with idea of getting up at a definite hour in the morning really awakens at that time. All these are phenomena of the very same conditional reflex order, cases of partial sleep with the sentry post awake in the cerebral cortex.

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(1) Pavlov, I.P. Selected Works, Moscow, Foreign Languages Publishing House, 1955, P., 355.

In the animal world the phenomenon of the sentry post not infrequently insures the life of the sleeping animals. For instance, when the octopus molluse is asleep seven of its appendages enterwine themselves around the body while the eighth appendage remains straight, slightly moving and keenly reacting to the external stimuli. Moreover, any contact with it immediately awakens the animal and the latter at once discharges a black pigment and generally displays an active defensive reaction. As for other examples of partial sleep we can cite cases of sleep while walking, horse back riding, as well as the pathological night sleep-walking. Generalized all of these phenomenas Pavlov observes that "the waking state of the organism always includes partial sleep and precisely in the subtlest relations of the organism with the outside world; and in the sleeping state there are always waking, active points in the cerebral hemispheres which are, as it were sentries on duty". (1)

From the point of view of Pavlov, the waking state is connected with the most concentrated form of inhibition. It is impossible not to agree with this if one remembers that a person who is wrapped up in one idea, as for instance happens with creative scientists, who devote themselves to realizing some cherished projects, literelly sees and hears nothing of what is going on around them. This is seen physiologically, in the cortex of a lively, active brain, in particular if this brain is occupied with complex, changing mosaic constituting of groups of neurons with different degrees of excitation or inhibition. In proportion as they are effected, with every alteration of states and experiences, these points and foci change places; a point where there was previously excitation now becomes the seat of inhibition, and *vice versa*. Consequently, Pavlov's mosaic is not something petrified or static; on the contrary it is very changeable very mobile. If the skull, as Pavolov stated many years ago, were transparent and the active portions had the property of emitting light, then external observation would give us a picture of an illuminated patch of very complex form which gradually moved about, continually encroaching on some portions of the cortex and deserting others. The illuminating patch would correspond to the region of maximum excitation, the creative positive portion of the cortex at a given moment. Every intense activity of the brain denotes a corresponding period of rest for the restoration of the reserves that have been used up. The more intense the strain, the more prolonged is the recuperation required.

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(1) *Ibid*, P. 357.

So far we were talking about the physiological basis of what is metaphysically known as the "Unconscious". It is time now to speak about the physiological foundations of dreams in connections with the solving of some scientific problems or generating creative ideas.

It may be affirmed without exaggeration that thanks to Pavlov's investigation of the physiology of sleep the age-old mystery of dreams was solved, and it was scientifically proved that dreams, as well as mental activity in the waking state, are based on the activity of the cerebral hemispheres, appearing and developing in accordance with the same strictly scientivc laws that govern other phenomena in the living nature. Dreams appear only when sleep is not sufficiently deep. During deep sleep inhibition involves the entire higher section of the brain, and also the deeper formations, the subcortical ganglia, i.e., the entire parts of the brain the activity of which is connected with human mentality. When sleep is light, mental life continues, and thus appear dreams, as the activity of the areas connected with their formation is not inhibited. But, what are the sources of dreams? Where do their contents originate? What material goes for their formation? One source of dreams may be simuli arriving from the outer world; these stimuli, in a distorted form, are percepted by the light sleeper. in his internal organs. Their causes are diverse: an uncomfortable position of the body, full bowels, extended bladdar, strained heart activity, or difficulty in breathing. However, the greatest source of dream material is the store of ideas, recollections and impressions retained by our memory. The physiological basis of memory is the traces left in our brain by previously received stimuli. In dreams these weak traces of former stimuli turn into vivid images and evoke various emotions. At the same time the principle of selection of the material of the dream may be of the most diverse nature. Very often people have dreams that reflected their everyday occupation and the emotions associated with it. Thus for instance, an artist who is painting a picture and is entirely absorbed by his work may often continue seeing this picture, in dreams, sometimes as already finished, sometimes as unfinished. This is true also, and mainly, of the scientific dreams mentioned above.

In the light of what has been said it is possible now to stress that we reject, on scientific basis, the existence of a special psychic entity in man called Unconscious in the Freudian or non-Freudian form. However, this does not deny the existence of non-cognized cognitive processes or forms of psychic activity which play an important role in the behaviour of man. Pavlov's teaching on higher nervous activity shows that analysis of psychological processes could not have full value without taking account of the nongonized forms of mental functions. However, it is possible for various complex and psychologically rich experiences to be suppressed so that they are removed from consciousnes but meanwhile remain intact in an inhibited condition. By the expression "non-cognized cognitive processes" we imply processes of higher nervous activity which are not accompanied by consciousness of reality. This expression is only an abbreviated designation for a certain category of cognitive processes which regulate behaviour but are not accompanied by conscious of reality. For precisely this reason the expression "noncognized forms of higher nervous activity" seems to be psychologically more adequate and to set off the difference between this approach from that of the metaphysical treatment of the Freud. Weakening of inhibition, they will again enter consciousness. As is well-known, various types of complex stimuli may act on man as signals eliciting complex reactions without the subject, being clearly aware of them. These may be active stimuli, motives arousing the subject to completion of a reaction, and even realization of the reaction itself. If unconscious forms of higher nervous activity are cerebral processes which do indeed exist, then how often do they appear? Are they only rare episodes arising under extreme conditions, under just those special experimental and true life situations which uniquely elicit them or, on the contrary, must we regard them as lawful components of common behaviour, as elements of any adaptive activity? And, finally, what is the role of these peculiar forms of higher nervous activity what is their relation to the activity of consciousness? It must be emphasized that it would be gross error to consider noncognized forms of higher nervous activity as rare episodes in the working of the brain.

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SECTION II: THE SOVIET APPROACH

A: Brain Mechanisms and Mental Processes

Attempts to discover the material substance for mental phenomena were undertaken in the very earlier days of philosophy, when they have no basis in postive facts. Gradually the naive materialistic concept of the mind as *pneuma* was supplanted by attempts to relate the complex mental functions to the material structures of the brain. In the fifth century B.C. Hipocrates claimed that the brain was merely the organ of senses. Calen in the second century B.C. offered a more precise explanation of the relationship between mental life and the brain. His system may be regarded as one of the first attempts to schemally localize mental phenomena in the structures of the brain. He assumed that the impressions received by man from the outside world enter the ventricles of the brain through the eyes in the form of humours. Further, he suggested that "internal chamber" containing these humours in the "temple" in which they meet the "vial" humours coming from the liver and are transformed by means of a network of vessels into the psychic humours.

With the passage of hime the view that cerebral ventricles *in to to* are the seat of mental processes gradually was refined, with structural differentiation of these ventricles and ascription of a special function to each one of them. Leonard da Vinci in the sixteenth century located each one of the three mental functions, as we shall see, in one of these ventricles.

The subsequent history of the idea of the cerebral localization of the mental processes was associated with the development, of psychology, which for a long time remained a branch of philosophy, on the one hand, and with the beginnings of descriptive anatomy of the brain, on the other. The conception of the mental functions began to become less rigid, and the image of the structure of the brain began to grow clearer. Nevertheless, the basic premise of direct superimposition of non-material psychological principle on material structure of the brain continued unchanged for many years. This explains why the first steps in the development of the science of anatomy in the new era were marked by the search for the particular part of the solid tissue of the cerebral organ that it could be regarded as the material substrate of mental processes. However, different investigators gave different answers to this question. Descartes, for instance, considered this organ to be the pineal gland. These attempts to find a single cerebral organ for all mental processes comprised the first step, in the investigation of functional localization. A school of psychology developed that subdivided mental processes into seprate, specialized faculties, and this led to a search for the material substrate of these faculties. The investigators of that era related the contemporary picture of the psychology of faculties to the current knowledge of the structure of the brain. The initial attempts at cerebral localization of faculties were therefore made by leading anatomists and they were highly speculative. These attempts to relegate individual mental functions to isolated parts of the brain were carried to their limit by Gall, and the faculties that Gall relegated to particular areas of the brain were simply taken from contemporary psychological teaching at that time. However, the suggestion that the cerebral cortex is a system with various functions, even if offered in a so fantastic and prescientific a form, was to some degree progressive, for it introduced a differential approach to an apparently homogeneous brain mass.

Nevertheless, there was considerable opposition to the idea of localizationism. Flourens, for instance, observed, on the basis of physiological experiments, that a short time after destruction of isolated areas of the cerebral hemispheres in birds, the behaviour of the birds is restored and, moreover, there is approximately the same degree of recovery regardless of which part of the cerebral hemispheres was destroyed. Although not yet aware that in the lower vertibrates, the cerebral cortex has a very low level of differentiation and that the functioning is inadequately corticalized, Flourens concluded that even if the brain as a whole is complex organ its cortex acts as a homogenous entity. However, his experiments marked a considerable advance from Gall's theoretical arguments. They replaced speculative presumption by scientific experimentation and directed attention to the plasticity and interdependence of the functions of the cerebral hemispheres. Furthermore, they anticipated the conceptions of the dynamic activity of the brain to which subsequent scientific thought has frequently returned. Although the concept of the brain as a single dynamic whole was put forward by physiologists, seemingly on the basis of accurate experimentation, the evidence that accumulated during subsequent decades dipped the scales once again in favour of localization. This evidence came now from clinical observations on patients with circumscribed lesions of the brain, on the one hand, and from the rapid development of anatomical and physiological research into the structures of the brain, on the other.

In April 1861 Broca exhibited the brain of a patient who had developed a disturbance of articulated speech during life before the Paris Anthropological Society. Postmortem examination of this patient revealed a lesion in the posterior third of the inferior frontal convolution of the left hemisphere. In November of the same year Broca conducted a similar demonstration of the brain of another patient with the same syndrome. In 1874 Wernicke described a case in which a lesion of the posterior third of the superior temporal gyrus of the left hemisphere caused a disturbance in speech comprehension. These cases provoked the suggestion that other mental processes, even the most complex, may be localized in comparatively small areas of the cerebral cortex and that the cortex is an aggregate of separate centres whose cell groups are depots of different mental faculties. All the attention of the neurologists of that time was therefore directed towards describing cases in which a lesion of a circumscribed area of the cerebral cortex caused a disturbonce of mainly one from of mental activity. However, investigators did not analyse the complex of the symptoms lying outside the confines of the disturbance of a single function, and they made no attempt to accurately describle the functional disturbance they had identified. Like Broca and Wernicke, they immediately concluded from a discovery of lesion in a particular area of the brain in an individual with a concommitant definite type of disturbance that the area containing the lesion in the centre for the function that had been impaired. The view that complex processes can be narrawly localized in circumscribed areas of the cerebral cortex would not have apread so widely or proved so successful had it not been for certain circumstances. The success of this theory was predetermined by the proposition of the contemporary psychology which by that time had become an independent branch of science. According to the prevalent school of thought, human mental activity is based on the association of sensation and ideas. Another and no less important factor in the favourable reception of the ideas of the localizationists of the second half of the nineteenth century, and without which these ideas would not have gained such wide acceptance, was the contemporary anatomy and physiology. The discovery of the highly differentiated structure of the cerebral cortex and of the possibility of strict differentiation of functions between its various parts may be counted among the great achievements of science. Accepting these discoveries as proof of the existence of distinct cortical centres for various motor or sensory functions, research workers now began to relate more complex mental functions of particular areas of the cortex with far more confidence than hitherto. In this way it began to be taught that not only are visual, auditory, and tactile, perception localized in the cerebral cortex, but such complex mental processes as counting, reading are also localized.

The suggestion that different areas of the cerebral cortex are highly differentiated in their structure and that complex mental functions are not uniformally related to the various areas of the brain were basically very progressive. They stimulated the more careful study of the brain and its functions. Nevertheless, the idea that highly complex mental phenomena may be localized in circumscribed areas of the cerebral cortex and that the circumscribed area responsible for a particular function can be directly deduced from a symptom naturally continued to arouse deep misgivings. During 1860s the celebrated English neurologist Hughlings Jackson formulated a series of principles in sharp opposition to the contemporary ideas of narrow localization. During the following decades, however, these principles were overshadowed by the successful progress of the localizationist's view, and it was not until the first quarter of the twentieth century that these ideas came to be widely accepted. Jacksons contemporaries took an incorrect and biased view of his ideas. His hypothesis pertaining to the complex character and vertical organization of functions was many decades ahead of the development of science at that time, and for a long time it remained forgotten, having been confirmed only recently. On the other hand, his declarations against the concept of narrow localization of functions in circumscribed areas of the cerebral cortex and his claims regarding the complex intellectual or voluntary character of higher psychological processes were soon adopted by the most metaphysically oriented investigators who regarded these viewpoints as support in their stand against the materialistic sensationalism of the classical neurology. But this attempt to deflect neurology into metaphysical channel of interpretation of mental processes encountered appreciable opposition.

The history of the problem of the localization of functions in the cerebral cortex, thus reached the present time. It was characterized by attempts to identify complex mental processes with the material structure of the brain and struggle between two apparently opposite factions, with the formulation of a theory mechanically combining the extremes of localizationism and anti-localizationism, it thus demonstrates what difficulties of principle bar the way to progress in psychomorphology. We have seen that from earliest antiquity, all attempts at solution have had to contend with two opposing schools of thought, one attempting to relate mental processes to circumscribed areas of the brain, with the brain regarded as an aggregate of separet organs, and the other assuming that mental activity is a single, individual phenomenon, a function of the whole brain working as a single entity. Each of these schools of thought has made its contribution to the development of scientific ideas regarding the brain and the principal forms of its activity. It cannot be denied that the localizationist's views, allowing for their occasianally grossly mechanistic, even fantastic, form, reflected, what, for that time, was a progressive tendency, i.e., to regard the brain as a differentiated organ. Nor can we overestimate the importance of the clinical discoveries of the localizationists. Without these achievements it would have been impossible to formulate any truly scientific theory of the functional organization of the cerebral cortex. At the same time, it cannot be denied that the antilocalizationists also made a substantial contribution to the development of modern ideas on the working of the brain. By insisting that the brain, although a highly differentiated organ, always functions as a whole, by stressing the fact that the brain tissue is highly plastic and that the brain is thereby able to recover its functions, and finally, by emphasizing that the tone of cortical activity is important for perfect functioning of the brain, the followers of antilocalization were incorporated into modern neurophysiological concepts. It must be remembered that, long before modern ideas on the working of the brain were evolved, members of the antilocalization school had introduced the concept of the vertical organization of functions, stressing the need for the analysis of hierarchical rela tionships of the different levels of the nervous system, However, both of the trends share a common psychomorphological feature: they both look upon mental functions as phenomena to be directly correlated with brain structure without intermediate physiological analysis, and they regard mental processes as properties incapable of further analysis, to be understood only as the direct product of the activity of cerebral structures.

It is important to mention here that between three and four centuries ago all human mental activity was regarded as the result of three fundamental faculties: the faculty of perception and imagination, the faculty of intellect and the faculty of memory. In the sixteenth century Leonardo da Vinci, as already stated, claimed that the material basis of these faculties lay in the three ventricles of the brain, of which the anterior was the organ of perception and imagination, the second as the organ of intellect and the third the organ of memory. About one hundred and fifty years ago similar attempt to identify complex forms of mental activity with localized areas of the brain was made by Gall on the basis of incomplete observation and speculative conclusions. He considered, for instance, that faculties such as love of children, respect towards parents could be localized in circumscribed areas of the cerebral cortex.

Psychomorphological attempts to localized mental functions in particular areas of the brain were natural at a time when in psychology, just as in physiology, the concept "function" was taken to mean the function of a particular organ. In modren psychology and physiology, new and incomparably more complex ideas on the formation of psychological activity and of the reflex mechanisms by means of which the organism maintains its equilibrium with the environment have been elaborated. In neuroanatomy, new concepts of the structure of the brain, advocating a material basis for the physiological reflex process, was elaborated. The task of creating a truly scientific approach to the localization of functions in the cerebral cortex was not tackled realistically until the work of Sechenov, followed by that of Pavlov, had created new chapter in physiology: the reflex basis of mental processes and the reflex laws governing the activity of the cerebral cortex. Not only did new teaching provide a new method to objectively analyse the more complex mechanisms of human and animal behaviour, but it also led to a radical revision of the concept of function whereby function began to be regarded as an aggregate of complex temporary connections. Further, this teaching introduced the view of the cerebral cortex as a collection of central apparatus for the analysis and synthesis of the external and internal stimuli and for the formation of temporary connections. It was as a result of the advances in contemporary physiology made by Pavlov that ideas on the dynamic localization of functions in the cerebral cortex were formulated, displacing the older, prescientific, psychomorphotogical concepts.

Scientific interest in the study of mental activity has sharpened in the past few decades. The human brain most delicate of all other argans, capable of reflecting the complexities of surrounding world-how is it built? and what is the nature of its functional organization? What structures or systems of it generate those higher mental functions which qualitatively distinguish man from the rest of the animal kingdom? How those nervous processes are organized and enable information derived from the ouside world to be received, analysed and stored? And how are those systems constructed its plan, regulate and then verify those complex forms of human activity which are directed towards the achievement of goals, fulfilment of designs and regulation of plans? Can the brain mechanisms, on which the human psychological processes are based, be the subject of deterministic analysis and scientific explanation, like all other phenomena of the objective world? Before trying to answer these questions it is necessary to clarify the meaning of determinism mentioned above.

In the history of scientific and philosophical thought determinism originated in connection with a mechanistic world view. It was originally a theory of causation conceiving of an external impulse which directly defined the end result of an external action. It is easy to see the worthlessness of this conception of determinism. Scientific facts and daily observation tell against it. At every step, we see that one and the same action can cause different reactions in different people, and that one and the same action can cause different reactions in the same individual under different conditions. All phenomena, not only of an organic but also of an inorganic nature, confirm this. The effect of any cause depends, not only on the nature of the object which acts upon another object but also on the nature of this second object; any change in one phenomenon is reflected in all others and is itself a response to the action of another phenomenon. This is the basis of the interconnection and interconditioning of all phenomena. The response is conditioned, not only by the nature of active phenomenon, but also by that of the phenomanon acted upon, as previously mentioned. The same general principle may be expressed in another way; in the preposition that external causes act through the medium of the internal conditions which are the basis for the development of phenomena.

Attempts to examine complex mental processes as functions of different local brain areas began, as previously stated, in the very distant past of human thought. In the European Middle Ages, in particular, pholosophers and naturalists condsidered that mental faculties would be localized in the three cerebral ventricles, and that at the begining of the last century the well-known anatomist, Gall, confidently asserted that the human faculties were located in particular and strictly confined areas of the brain. If these areas are particularly well developed, this will lead to the formation of prominence in the corresponding parts of the skull, and observations on such prominences can therefore be used to determine individual differences in human faculties. Gall's phrenological charts were attempts to project, without much factual basis, the psychology of Faculties in vogue at that time on to the brain.

and they were therefore very quickly forgotten and followed by attempts to distinguish functional zones of the cerebral cortex on the basis of positive observations on changes in human behaviour taking place after local brain lesions. The true birth of scientific investigation of the disturbance of mental processes can rightly be taken as 1861 since Broca, as already mentioned, postulated that the posterior third of the left inferior frontal gyrus is the centre of the motor images of words – the spoken words – . In 1871 the German psychiatrist, Wernike, described cases where a lesion of another part of the brain, this time the posterior third of the left superior temporal gyrus, gives rise to an equally clear picture but now of the opposite kind, loss of ability to understand audible speech, while expressive (motor) speech remained relatively unaffected. As a result of this intense intense interest in the direct localization of brain functions in circumscribed zones of the cerebral cortex, within a very short time (the splendid seventies of the last century) many centres were discovered in the cerebral cortex : a centre for concepts (in the left inferior parietal regions), a centre for writing (in the posterior part of the left middle frontal gyrus). a centre for mathematical calulation, a centre for reading, and so on. The accumulation of more material about the cerebral centres did not stop these attemps, and the tendency to localize complex psychological processes in local areas of the brain continued for more than half a century, with the addition of new facts from observations on patients with local brain lesions resulting from wounds or haemorehage.

It would be wrong, however, to suppose that the attempts to localize complex psychological processes directly in certain brain areas, or as it is generally called "narrow localiza tionism" remained the general line of development of neurological thought and that it encountered no natural opposition among influential neurologists. Even at the dawn of its development, in the splendil seventies, Broca and his followers encountered powerful opponent in the person of the famous English neurologist: Hughlings Jackson,⁽¹⁾ who put forward the hypothesis that the cerebral organization of the complex mental processes must be approached from the standpoint of the level of their construction rather than of their localization in particular areas of the brain. But Jackson's hypothesis, too much complex for his time, was not taken up and developed until fifty years later, when it emerged once again in the writings of emineut neurologists in the first half of the present century. Jackson's conceptions were without a doubt progressive. However, despite the advantages of the evolutionary – dynamic conception, Jackson's idea had hidden within it considerable dangers. The most fundamental of these lay in the fact that by concentrating all attention on the level of organization of various functions this idea in fact discouraged concrete analysis of the topical aspects of various brain mechanisms in the performance of various mental functions and that not infrequently the brain came to be considered as a single unit not to be analysed into its various parts. The danger of the holistic point of view is manifested in a large number of the investigations carried out in the past fifty years. The lack of concern for neuroanatomy and neurophysiological bases of mental functions prevented investigators from achieving geniune success. A scientific approach to the analysis of mental processes and their cerebral organization, while taking into account the level of organization of various functional systems, must not renounce the study of specific brain mechamisms.

Investigators following Jackson's idea pointed with every justification to the complex character of human mental

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(1) Jackson, H. "On the Anatomical and Physiological Localizations of Movements in the Brain", in Pribram, K.H., editor, Brain and Behaviour, London, Penguin, 1969, Vol. II PP. 470—490.

activity and postulated that this activity is the result of the working of the whole brain rather than the product of the work of local areas of the cerebral cortex. Doubt about the possibility of narrow localization of complex mental processes led these researches either to divorce the mental processes from the brain structure and recognize their metaphysical nature, the position adopted towards the end of their lives by such greater investigators as Monakow⁽²⁾ and Sherrington,⁽³⁾ or to attemp to show that these psychological processes are the highest level of brain activity, depend more on the mass of the brain involved in the process rather than the participation of specific zones of the cortex.⁽⁴⁾

The reasonable doubt regarding the validity of the mechanistic approach of the narrow localization thus led either to the revival of the old metaphysical notion of mind or to the revival of the other idea: the brain is undifferentiated entity, and the decisive role of its mass in the performance of mental activity, which has repeatedly burst forth through the history of the study of brain as the organ of mind: Flourens (1824) and Goltz (1876). Naturally the situation compelled a search for new ways leading to the discovery of the true cerebral mechanisms of the highest forms of mental activity, retaining the same scientific principles of investigation for their examination as have proved themselves in the study of elementary forms of psychological processes, but which would be adequate for the study of human mental processes, with their socio-historical origin, and their complex, hierarchical brain structure. The fundamental position from which one must construct a scientific theory of brain mechansms is a conception of psychological processes as highly differentiated

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(2) **Pribram, Ibid, Vol. I, PP. 27—36.**

(3) **The Physical Basis of Mind, London, Black Well, 1952, P. 5.**

(4) **Lashley, K.S., Intelligence & Brain Mechanisms, N.Y., Dover, 1949.**

functional systems. This fact becomes clear if we remember that the behaviour of an organism, beginning with the simplest reactions of living protoplasm, is determined by the specific conditions of its existence in a given environment, by its needs, and by its reactions to stimuli which act upon it. These reactions make possible the best conditions for meta bolism by maintaining an equilibrium between the organism and its environment. When, in the process of biological development, the environment conditions in which an organism life becomes more complex, its continued existence demands new, more complex forms of adaptation to that environment. There arise receptors and complex variable mechanisms. At this stage adaptation to environment comes to be accomplished by means of the distance receptors and those forms of functional apparatus for analysis and synthesis which Pavlov, as we shall see, named analysers. It is only natural that at the stage all adapting – orienting – activity and the active behaviour associated with it takes on the character of complex and dynamic functional systems by means of which the organism adapts to everchanging aspects of the environment. The appearance of temporary connections based on a highly complex dynamic mosaic of excited and inhibited points in the brain cortex constitutes a most important form of analysis and synthesis of external stimuli. It leads to the formation of those complex functional systems which permit the organism to successfully equilibrate with its environment Accordingly, localization of functions becomes the dynamic distribution of functional systems in the central regions of the nervous system and especially in the cerebral cortex: the dynamic constellations of cerebral zones, each of which comprises part of the cortical portion of a given analyser and preserves its specific function, while participating in its own way in the organization of one or another form of activity.

The linkage or connection between brain structure and mental process or psychological functions (language, attention, memory, perception, thinking) has, for a long time been at the centre of attention of researchers in the field of psychology and neurology, as has previously repeatedly stated. For decades the psychological processes were regarded as direct experiences or as primary properties of the mind in its metaphysical meaning. They were treated, accordingly, as inaccessible of further analysis. However, all previous attempts to find their brain mechanisms were nothing other than sporadic attempts aimed to find topologlical areas in the brain which might serve as direct seats, carriers or organs of the mental processes. Hance, one of the urgent tasks of modern psychology is to give a scientific neurological interpretation of the physical basis of the human mental activity, instead of the absolute psychomorphological principle of the narrow localizationism of the psychological processes, which once contributed to the scientific progress in the last century, but which has long since retarded its further development. In contrast to the principle of narrow localizationism, the Soviet neuro-psychology the new principle of dynamic localization of mental functions formulated long ago by Pavlov and developed further by Luria and other eminent Soviet neuropsychologists. In the Soviet Union, neurospychology or the science of the cerebral organization of the human mental processes is still a very young human discipline, taking its very first step, and a period of few decades is not a very long time for the development of any science. nevertheless, it has so far shaded a bright scientific light on the physical basis of human mental processes. What follows is a short summary of the main ideas concerning the brain mechanisms of the psychological functions of man as they were advanced by the noted Soviet neurologist Polyakov(1) and the outstanding Soviet neuropsychologist Luria(2).

The view that mental functions are directly located in some circumscribed centres of the cerebral cortex must imply that destruction of the localized centres of the cortex will lead to the loss of these corresponding mental functions, and that such a loss of functions cannot arise as a result of lesion of other parts of the cortex not involving the particular centre. It means an isolated pathological focus must lead to disturbance of only its own particular behavioural function, without affecting the other psychological processes whose central centres are situated in other regions of the cortex. None of these assumptions, essential to psychological ideas, have been proved true in practice. Numerous observations made by neurosurgeons on patients with gunshot wounds and tumours of the brain have shown that a disturbance of a particular complex function does not in fact arise in association with a narrowly circumscribed lesion of one part of the cortex, but is observed, as a rule, in patients with lesions of several different parts of the brain. Disorders of writing, for instance, may appear in lesions of the temporal, post central, premotor and occipital-parietal regions of the brain, and all attempts to relate the complex act of writing to one localized cortical centre can be dismissed at the very outset. The same remarks apply to reading (which may be affected in occipital temporal and frontal lesions of the left hemisphere), to arithmetical operations, to understanding of speech, to active motor speech and so on. There is no doubt that each of these phenomena may be most marked and most clearly defined in patients with local lesions in certain parts of the cortex. However, the facts suggest that a disturbance of a particular form of activity may arise in far more extensive lesions than was hitherto supposed, although each time it may differ in charcter. Consequently, the performance of a given function necessitates the integrity of far more extensive and far more structurally varied zones of the cortex than was assumed by classical neurology. It is interesting to note that even the morphological verification of Broca's famous case, with which attempts at the localization of motor speech in cirumscribed centres of the cerebral cortex began, that the focus of destruction in this patient extended far beyond the limits of the region described by Broca himself, and the affected regions are far posteriorly to the centre of the motor images of the words which Broca described. Hence, the factual evidence of clinical neurology sharply contradicts the suggestion of the direct localization of psychological functions in circumscribed areas of the brain.

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(1) Poliakov, G.I., On the Neuronal Organization of the Brain, Moscow, Mir Publishers, 1971.

(2) Luria, A.R., Higher Cortical Functions in Man, London, Tavistock Publications, 1966.

Another fact, established firmly in clinical neurology for the last few decades, cannot be reconciled with the ideas of psychomorphology. A lesion of a narrowly circumscribed area of the cortex practically never leads to the loss of any single isolated mental function, but always to the disturbance of a large group of mental processes. For instance, a local lesion of the cortex of the external portions of the left temporal region causes a disturbance of the understanding of speech which is by no means isolated as Wernicke suggested. It is inevitably accompanied by a disturbance of the ability to analyse the sounds of speech, and causes a disorder of the repetition and memorizing of words, gross defects of writing and a disturbance of intellectual operations, which leaving relatively intact orientation of space discrimination of direction, and written arithmetical operations. Lesions of the parietal or parieto-occipital regions of the left hemisphere likewise never cause the limited defects described by the classical neurologists. While causing defects of orientation in space, they just as inevitably cause gross disturbance of numbers and arithmetical operations, and a disturbance of understanding of complex logico - grammatical structures, while leaving relatively intact processes such as speech, the perception and reproduction and musical melodies, and so on. We are forced, therefore, to the conclusion that the human brain and its cortex can in no way be regarded as conglomiration of individual organs each of which is the centre for a certain isolated function.

Another group of facts in sharp contradiction to the psychomorphological ideas of the direct localization of psychological functions in circumscribed areas of the cortex is given by the analysis of the restoration of functions after local brain lesions. It is firmly estiblished that the neurons of the cerebral cortex when destroyed, do not regenrate. The supporters of the direct localization of psychological functions in circumscribed centre of the cerebral cortex therefore suggested with full justification that a function lost after destruction of its corresponding centre could be restorted; cases of the restoration of disturbed functions are artibuted by them to the presence of reserve "vicarious" centres in the symmetrically opposite regions of the cerebral hemispheres, which assumed the role of destroyed centre, as result of which the lost function could be restorted. However, experiments on animals and clinical observations on patients with local brain lesions do not confirm these suggestions.

The traditional conception of cortical centres in which groups of cells possess certain mental faculties must give way to the conception of complex cortical reflex systems, which carry out the physiological processes underlying complex forms of mental activity. Modern work in neuronal architectonics and neurophysiology give good supporting evidence for the latter conception. The cerebral cortex with its six cell layers can be considered a highly complex reflex organ for two reasons: first, we know that each cortical area has fibers entering it and fibers leaving it. Secondly, we know that reflex processes occur in each area. In other words, the time has passed when mental processes could be considered separate faculties or functions – processes – of the mind. It is now clear that even the highest forms of mental processes should be thought of as the product of complex reflex activity, which possesses both afferent and efferent links since human behaviour involves striving to reach goals within a given environmental context. The environment imposes certain conditions, and human behaviour involves analysis of the conditions and selection of the most appropriate paths by which goals may be reached. In short it involves complex analytic

- synthetic activity directed towards solving of difinite problems. Successful actions are reinforced thus giving rise to the concept of back afferentation or feedback. Through feedback successful actions are separated from all the rest and they become dominant, while irrelevant actions are simultaneously inhibited . On the basis of past experience stored in the form of visual images or verbal associations man orients to problems, creates schemata of possible solutions, - and submit his behaviour to them.

In the light of what has been repeatedly stressed, it is essential to emphesize once more that no form of mental activity can be thought of as function localized in a limited group of nerve cells. Any form of mental activity, especially speech, is a complex functional system of mechanisms, which are dynamically dispersed about the cortex and which must be accomplished by a complex of cortical and adjacent subcortical areas working in coordination with one another. The roles of different areas are not identical: each makes its own contribution to the general, to the dynamic structure, of cortical zones carrying out a given function.

Physiologists have long been aware of the fact that complex forms of behaviour must involve the combined activity of numerous functional systems which are related to structures widely distributed in the brain. Analysis of such systems has shown that they are never localized in a single cortical centre, but rather they require the joint participation of afferent and efferent which often involve structures at many levels of the brain and in different parts of the cortex. Together the processes constitute a single, complex and liable unit of activity. Thus, if we wish to discover the morphological substrate of a complex functional system we must accept from the outset that we are not looking for isolated centre fixed once and for all, but that we seek a pattern of neural structures which operate jointly to produce the complex activity in question.

Whereas the elementary physiological functions (sight or hearing, touch or simple movements) if disturbed after local lesions of corresponding areas of the human cerebral cortex are practically incurable of regeneration so that the defect persists throughout the life , the fate of other, more complex forms of mental activity, which also are obviously affected by local brain lesions, is completely different. The restoration does not take place by the simple transfer of the disturbed function to a "vicarious" part of the symmetrically opposite hemisphere, but it has the incomparably more complex character of a functional reorganization of the disturbed activity. It is therefore that the complex forms of behavioural activity are not simple properties incapable of further subdivision, and are not associated with particular group of narve cells in the cortex, and they are not lost in their entirity in local lesions of the cerebral cortex destroying the corresponding centres.

For a long period attempts to solve the prablem of the cerebral basis of mental activity in man set out from obsolete and philosphical unsound parellelistic positions. According to these views, psychological functions were regarded as relatively independent, indivisible properties of mental life, localized in circumscribed areas of the brain, which form their material basis and which were conventionally regarded as centres of the corresponding mental functions. In its existence forms these views, which have persisted substantially unchanged until the present time, were expressed in ideas according to which the human brain is regarded as a conglomerate of individual morphological organs each of which has a rigid hereditary established mental function. Apparent confirmation of these views seemed to be backed by clinical studies of patients with local brain lesions, indicating that a lesion of circumscribed areas of the brain is accompanied by the loss of isolated mental functions. Although these concepts are apparently so firmly established, and although their theoretical foundations have remained untouched for centuries, apart from minor changes in form, careful observation shows that they have long ceased to correspond to the facts and that they require a radical revision. The clinical evidence shows, as previously stated, that any complex behavioural function – perception, action, speech, writing, reading, caculation – is never lost in a patient with a lesion of only one circumscribed area of the cortex, but it may be impaired in lesions of widely different areas of the brain, sometimes far distant from each other. At the same time, a lesion of one circumscribed area of the brain, as we have repeatdely stressed, never leads to the isolated loss of any one complex behavioural function, but causes a group of disturbances which although they always possess some common link, is reflected in the normal course of what are apparently diverse functions. These facts have compelled the radical revision, as previousely stated, both of the earlier ideas of functions as well as of the obsolete views on the forms of the organization of the brain and its cortex. According to the Soviet modern views, notably of the famous Soviet physiologist Bernstein, the two meanings of the concept "function" must be strictly distinguished: function as the activity of a particular tissue and function as a complex adaptive activity, performing a certain task, which is in reality a complex functional system. Human behaviour, manifested in complex forms of reflection of the outside world and complex forms of regulation of activity always belongs to the second of these meanings – categories – and is always, constructed as a series of complex functional systems, laid down in the course of socio – historical development, and based on complex forms of reflex processes.

It is important in this connection to emphatically stress here that the Soviet neuropsychologists and neurophysiologists, notably Luria and Poliakov whose views are expressed in this section, have taken as the basis of their analysis of the construction of the brain not its traditionally accepted divisions into anatomical parts but the new principle of functional localization. In tracing the various stages of the complication of the animal reactions – together with their corresponding transformations of neuronal structure – from the standpoint of their evolution, they consider them as the material expression of the interaction of these main functions governing the whole adaptive Potential of the organism, namely, the function of regualtion, control and direction. In their conception, the Soviet investigators, regard these functions and their morphological substrate as the neurophysiological foundation for active orientation in the external world, analysis and synthesis of all external and interníal signlling stimuli, and the programming and performance of responses to stimulation. These functions embrace all manifestations of reflex activity from the simplest to the most complex at all stages of evolutionary development.

There are soild grounds for distinguishing three principal functional systems of the brain whose participation is necessary for any type of mental activity. With some approximation to the truth they can be described, from the Soviet point of view natably of Luria, as the unit for regulating the tone or the waking state of the organism, the unit for obtaining, processing and storing information arriving from the outside world, and the unit for programming, regulating and verifying mental acitivity. Man's mental processes always, take place with the participation of all three units, each of which has its role to play in mental processes and makes its contribution to their performance. Their first important feature is their hierarchical structure. Another important feature is that each of these basic units itself is hierarchical in structure; and the first, second and the third units consist of three cortical zones built one above the other; The primary (Projection) area which receives impressions from or sends impulses to the periphery or the secondary (projection – association) area, where incoming information is processed or programmes are prepared, and, finally, the tertiary or zones of overlapping, the latest systems of the cerebral hemispheres to develop and responsible in man for the most eomplex forms of mental activity.

Thus, it is possible to distinguish three basic laws governing the work, structure of the individual cortical regions composing the three functional units of the brain. The first is the law of the hierarchical structure of the cortical zones. The second law governing the work of these units or functional brain systems can be expressed as the law of diminishing specificity of the hierarchically arranged cortical zones composing it. The third fundamental law is the law of the progressive lateralization of functions, implying their progressive transfer from the primary cortieal areas to the secondary and, ultimately to the tertiary areas. However, it would be a mistake to imagine that each of these units can carry out certain form of activity completely independently; each form of human conscious activity is always a complex functional system and takes place through the combined working of all three brain units, each of which makes its own contribution. The first unit is located in the brain – stem, the diencephalon, and the medial regions of the cortex. The second is located in the lateral region of the neocortex on the surface of the hemispheres, of which it occupies the posterior regions including the visual, auditory and parietal regions. The third is located in the frontal lobe. The following is a detailed analysis of each one of them beginning with the first functional system of the brain.

For human mental processes to follow their correct course, the waking state is essential. It is only under waking conditions that man can receive and analyse information, that the necessary selective systems of connections can be called to mind, his activity programmed, and the course of his mental processes checked, his mistakes corrected, and his activity kept to the proper course. A most important dis-covery, made in 1949, was that the structures, maintaining and regulating cortical tone, do not lie in the cortex itself, but below it, in the subcortex and brain stem. It was also discovered that these structures have a double relationship with the cortex, both influencing its tone and themselves experincing its regulatory influence. The year 1949 initiated a new period in our knowledge of the organization of the brain. In that year two oustanding investigators, Magoun⁽¹⁾ and Morruzzi showed that there is a special nervous formation in the brain stem which is especially adapted, both by its morphological structure and by its functional properties, to play the role of a mechanism regarding the state of the cerebral cortex, changing its tone and maintaining its waking state. With the dis-covery of the reticular formation, a new principle was thus introduced: the vertical organization of all structures of the brain. This put an end to that long period during which the attention of scientists attempting to discover the nervous mechanisms of mental processes concentrated entirely on the cortex. The reticular formation of the brain stem is a powerful mechanism for maintaining cortical tone and regulating the functional state of the brain. and it is a factor determining the level of wakefulness. However, besides the activating portions of the reticular formation, it also has inhibiting portions. Accordingly, whereas stimulation of certain nuclei of the reticular formation leads invariably to activation of the brain, stimulation, of its other nuclei leads to changes characteristic of sleep in the electrical activity of the cortex, and to the development of sleep itself.

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(1) Magoun, W.H., The Waking Brain, Springfield, Thomas, 1949.

The second functionral unit or system of the brain is the unit for receiving, analysing and storing information, and is located in the lateral regions of the neocortex on the convex surface of the hemispheres, of which it occupies the posterior regions including the visual (occipital), auditory (temporal) and general sensory (parietal) regions: the reception of visual, auditory, vestibular or general sensory information. The parts of this sytem also incorporate the central parts of gustotary and olfactory reception, in man these later parts are so overshadowed by the central representation of the higher exteroceptive systems, receiving stimuli from the objects at distance, that they occupy a predominantly minor place in the cortex.

The basis of this unit is formed by the primary or projection areas of the cortex, which consists mainly of neurons of the afferent layer IV, and are surrounded by the systems of the – gnostic – cortical zones superimposed above them, in which the afferent layer IV yields its dominant position to the layers II and III of cells. This hierarchical structure is equally characteristic of all regions of the cortex constituting the second functional unit of the brain. In the visual (occipital) cortex, above the primary visual area (Brodmann's 17) there is a superstructure of secondary visual areas (Brodmann's areas 18 and 19). The auditory (temporal) cortex is constructed in accordance with the same principle. Its primary – projection – areas are concealed in the depth of the temporal cortex in the tranverse of gyri Heschl (represented by Brodmann's area 41). Just like the primary visual area, these primary parts of the auditory cortex have a precise topographical structure. Above the systems of the primary auditory cortex are superimposed those of the secondary auditory cortex, located in the outer parts of the temporal region in the consvex surface of the hemisphere (Brodmann's areas 22 and part of area 21), and which also consists predominantly of powerfully developed layer II and layer III of cells. Finally, the same functional organization is also preserved, in principle, in the general sensory – parietal – cortex. Just as in the visual and auditory cortex, it is based on primary projection zones (Brodmann's area 3), the substance of which also consists mainly of neurons of layer IV. Above the primary zones of the general sensory – parietal – cortex are superposed its secondary (Brodmann's areas 1, 2, 5 and part of area 40). Like the secondary zones of the visual and auditory cortex these zones consist mainly of associative neurons of layers II and III, and their stimuuation leads to the appearance of more complex forms of cutaneous and kinesthetic sensations.

In accordance with the morphological differences between the two groups of cortical areas (the primary areas constituting one group and the combined secondary and tertiary areas making up the other), their functional characteristics are also quite different: primary visual area 17, and primary auditory area 21; the secondary visual areas 18, 19 and the secondary auditory areas 22, 42. Generally speaking, the secondary and tertiary zones of the cerebral cortex appear late in phylogenesis and provide for the most complex forms of integrated function involving different analysers. In the later stages of phylogenesis the cortical nuclei of the various analysers became more differentiated.

All zones described above are in fact adapted so as to serve as an apparatus for the reception, analysis and the storage of information arising from the outside world, or , in other worlds, the cerebral mechanisms of modally specific forms of gnostic processes. However, human gnostic activity never takes place with respect with exclusively one single isolated modality (vision, hearing, touch). The perception – and still more, the representation – of any object is a complex procedure, the result of modal activity, originally exponded in character later concentrated and condensed. Naturally, therefore, it must rely on the combination of the working of complete systems of cortical zones.

The secondary zones of the occipital cortex differ considerably from the primery – projection – zones over which they are placed both in their structure and in their functions. The distinguishing feature of the secondary zones of the occipital cortex is the fourth – afferent – layer of cells, receiving stimuli from the retina, is much smaller here than in the primary zones (Brodmann's area 17).(1) Conversely, the upper associative layers II and III, consisting mainly of cells with short axons, now constitute the greater part of the thickness of these secondary or projection – association zones (Brodmann's areas 18, 19), which have recently been named intrinsic cortical areas,. A section through the layer of zones between the primary 17 and secondary 18 areas of the occipital cortex clearly demonstrates the radical changes which take place in the cytoarchitectonic structure of the cortex from the primary to the secondary zones. The secondary zones of the occipital cortex have also undergone substantial changes by comparison with the primary zones in the course of evolution. Whereas in the lower monkeys – with their powerfully developed visual cortex – its primary (projection: Brodmann's area 17) is much more extensive than the secondary zone, in man this ratio is reversed, and the secondary visual zone (Brodmann's are 18) is now distinctively larger than the primary visual cortex. "The morphological studies of the Moscow Brain Institute showed that the distribution of the nerve cells in the cortex of the primary and secondary occipital zones (Bradmann's 17, 18) differ very considerably, Whereas cells of the afferent layer IV are distinctly predominant in the primary visual cortex (area 17), these cells are less numerous in the secondary visual cortex (area 18) where most cells are located in the upper associative layers II and III". (1) It follows that the secondary zones of the visual cortex, with their complex structure and their facility for the extensive spread of excitation, play the role of synathesizing visual stimuli, coding them, and forming them into complex systems. "It can therefore be concluded that the function of the secondary zones of the occipital cortex is to convert the somatotopical projection of incoming visual excitation into its functional organization. Consequently, these zones play a decisive role in the provision of a higher level of processing and staring of visual information". (1)

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(1) Taken from Brodmann's classical map 1909 of cartical areas, which, with some variation, have been accepted through the work of Moscow Institute of Brain founded 1924,

We have examined the functional organization of the primary and secondary zones of the occipital regions of the brain and their role in the formation of visual perception. We shall now briefly examin the functional organization of the primary and secondary zones of the temporal regions and their role in the auditory analysis and synthesis. The auditory-temporal-cortex occupy the lateral convex portions of the temposal region of the brain and, just as in the case of the visual – occipital – region, it is divided into primary – projection – and secondary auditory zones. The organization of the projection zones of the auditory cortex differs from that of the occipital – visual-cortex in that there is no complete representation of each ear (or of some of the auditory fibers) in each one of the opposite – hemispheres. The fibers of each organ of cortical area represented in both projection zones of the auditory cortex, and they are merely represented predominantly in the opposite himesphere. The secondary zones of the auditory cortex – occupying the lateral convex portion of the temporal lobe in man, corresponding to Brodmann's area 22 and part of area 21 – have the same structure as the secondary zones of the other sensory areas. They consist predominantly of cortical layers II and III.

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(1) Luria, A.R., The Working Brain, London, Penguin, 1973, P. 113.

(1) Ibid, P. 115.

However, there are other gnostic processes, playing a leading role in human conscious activity, which depend on the combined working of several analysers. They form the basis of the higher forms of human gnostic activity, and we must now examine them in details. I refer to the zones of the cortex which lie between the occipital, the temporal and central regions and which play a basic role in the organization of the complex simultaneous – spatial – synthesis: the tertiary zones: the zones of the posterior regions of the brain that lie at the boundry between the occipital, temporal and postcentral regions of the hemisphere, where the cortical areas for visual, auditory, vestibuler, cutaneous and proprioceptive sensation overlap, are tertiary in function. Their centre is formed by Brodmann's areas 39 and 40 or the interior parietal region although there are no strong grounds for excluding the adjacent tempero – occipital formations of area 37 and 21 from them. These zones, which perceive the transverse situation and the well-marked six-layer structure characteristic of all receptor zones, consist entirely of cells of the upper cortical laryers, with short axons and predominantly associative functions. These zones are formed only in man and they constitute the specifically human portions of the brain. They mature later than all other zones of the posterior regions of the cortex, and do not become fully operative until the second year of life. This suggests that the tertiary zones of the parieto-temporo-occipital region, now to be described fully, play a special region, now to be described fully, play a special rôle in the inter-analyses syntheses, and that they are concerned with the integration of individual impulses within the same-visual, tactile-analyser as well as with the transfer of structures of the excitation of one analyser to another.

It is the tertiary zones of the second brain unit, the zones fo overlapping of the cortical ends of the various analysers, which are responsible for enabling groups of several analysers to work concertedly, these zones lie on the boundary between the occipital temporal and post central cortex, and the greater part of them is formed by the interior region which, in man, has developed to a considerable size, occupying about one-quarter of the total mass of the system we are describing. It can terefore be considered that the tertiary zones, or the posterior associative centre, are specifically human structures.

These tertiary zones of the posterior region of the brain consist almost entirely of cells of the associative layers, II and III of the cortex and, conequently, that they are concerned almost entirely with the function of integrating of excitation arising from different analysers. "There is reason to suppose that the great number of neurons in these zones are multimodal in character, and there is evidence to show that they respond to general features, (for example, to the character of special arrangement, the number of component), to which the neurons of the primary, and even the secondary, cortical zones are unable to respond," (1) These tertiary structures of the posterior zones of the cortex include Brodmann's areas: 5, 7, 39, and 40 – the superior and inferior zones of the partietal region – , areas 21 of the temporal region, and areas 37 and 39 of the temporo – occipital region. The principal role of these zones is connected with the spatial organization of discrete impulses of excitation entering the various regions and with the conversion of successive stimuli into simultaneously processed groups, the only possible mechanism for that synthetic character of perception which Sechinov originally discussed many years ago.(2) This work of the tertiary zones of the posterior cortical regions is thus essential, not only for the successful integration of information reaching man through his visual system, but also for the transition from direct, visually represented syntheses to the level of symbolic processes – or operations with word meanings, with complex grammatical and logical structures, with systems of numbers and abstract relationships. It is because of this that the tertiary zones of the posterior cortical regions play an essential role in the conversion of concrete perception into abstract thinking.

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(1) Luria, A.R., The Working Brain, London, Penguin, 1973, P. 73.

(2) Sechinov, I.M., Selected Physiological and psychological Works, Moscow, Foreign Languages Pub., House, no date, P. 74.

From what has just been said it is clear to distinguish, as already stated, three basic laws governing the work of the structure of the individual cortical regions composing the second functional brain unit we are so far speaking about,. The first law is the law of hierarchical structure of the cortical zones: The primary, the secondary, and the tertiary. The second is the law of diminishing specificity. This property is a feature of both the primary-projection-areas of the visual (occipital) cortex and of the primary – projection – areas of the auditory (temporal) or the general sensory (post central) cortex. Secondary cortical areas in which the upper layers with their associative neurons are predominant, possess this modal specificity to a much less legree. This modal specificity is represented to an ever lesser degree in the tertiary zones of the second functional brain unit. The fact that these cortical areas can be described as zones of overlapping of the cortical ends of the various analysers is itself sufficent to show that the modal specificity of its components is less highly represented, and that although one can point to the simultaneous – spatiel – syntheses performed by these zones of the cortex, it is virtually almost impossible to suggest that they are modally specific – vitsual or tactile – in character. Thus, the law of dimishing specificity is, in fact, another aspect of the already familiar law of hierarachical structure of individual cortical areas forming this second brain system and responsible for the transition from concrete reflection of particular modally – specific aroas to the integrated reflection of more general and abstract schemes of the perceived world.

The third law is the law of the progressive lateralization of functions, implying, as already mentioned, their progressive transfer from the primary cortical areas to the secondary and, finally, to the tertiary areas, "The primary cortical areas of both cerebral hemispheres, whose structure is based on the somatotopical projection, are known to have identical roles. Each of them is the projection of contralateral reception surface, and there is no question of any dominance of the primary areas of either hemisphere. The situation is different with regard to the secondary and, still more, with regard to the tertiary areas. With the appearance of right-handedness (which is associated with work, and which evidently relates to a very early stage of man's history) and later with the appearance of another related process, namely, speech, some degree of localization of functions begins to take place, which has not yet been found in animals but which in man has become an important principle of the functional organization of the brain". (1) The left hemisphere – in right – handed persons – has become dominant. It is this hemisphere which begins to be responsible for speech functions, whereas the right hemisphere, unconnected with the activity of the right hand or with speech, has remained subordinant. This principle of localization of localization of functions has naturally become a new and decisive principle of the functional organization of the cerebral cortex. The left – dominant – hemisphere (in the right – handers) begins to play an essential role in the cerebral organization of all

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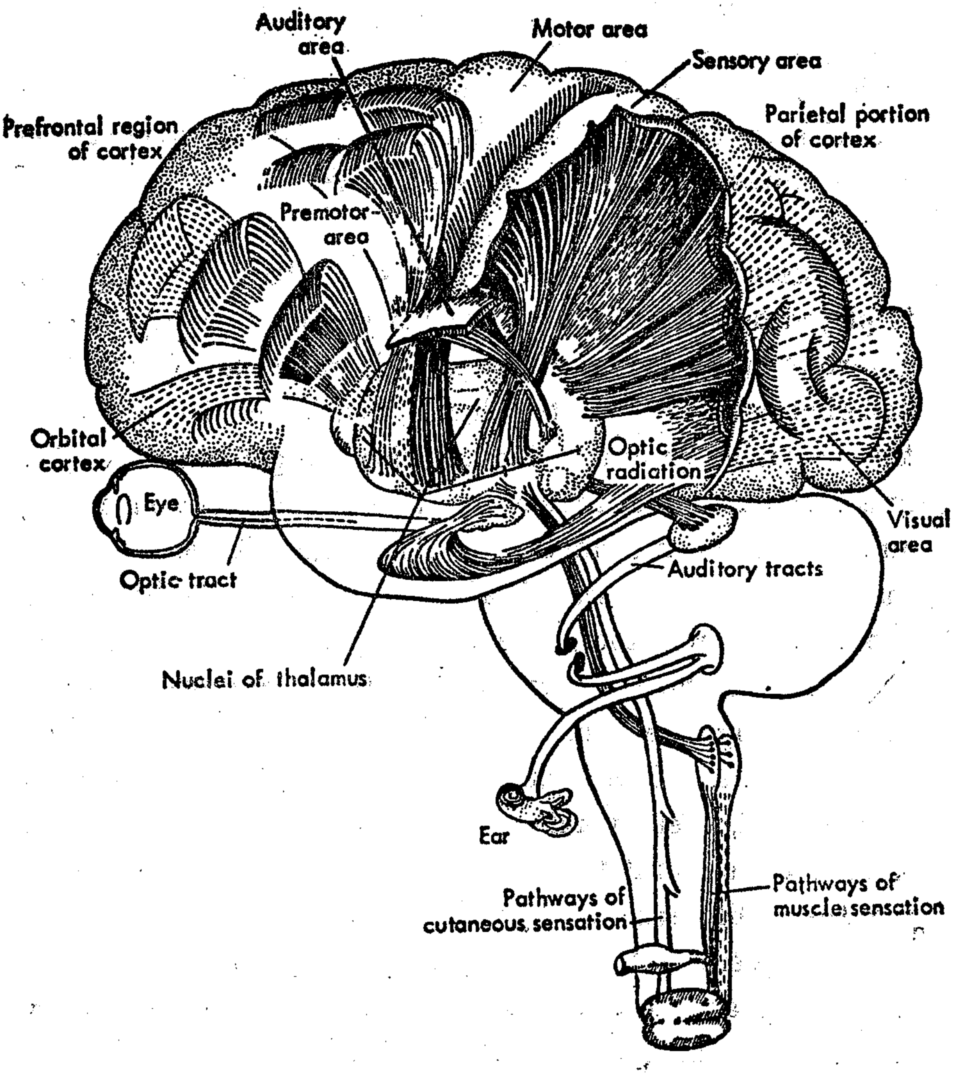
(1) Ibid., P. 77.



Cortical zones of systems of analyzers. (After Papez, 1958.)

connections necessary for some forms of the intellectual activity . Similar facts are revealed by the use of electrophysiological methods. It is interesting to note here that under normal conditions the presentation of any complex task requiring increased attention arouses changes in the electrical activity of the brain which has been described as desynchronization or depression of the alpha ryhthm. In such cases the electrical waves with frequency of 8–10 per second known as the alpha ryhthm are depressed whereas the faster waves are increased in amplitude.

A decisive role in the preparation of the motor impulses is played by the superposed secondary and tertiary zones, governed by the same principles of hierarchical organization and diminishing specificity, which I mentioned when discusing the principles governing the functional organization of the first functional unit of the brain: the unit of reception, coding and storage of information. The main difference now is that whereas in the second, afferent system of the brain, the processes go from the primary to the secondary and tertiary zones, in the third, efferent system the processes run in in descending direction, starting at the highest levels of the tertiary zones. The second feature distinguishing the work of the third, efferent unit of the brain from that of the second, afferent unit, is that the unit itself does not contain a number of different modally-specific zones representing individual analysers, but consists entirely of systems of efferent, motor type and is itself under the constant influence of the structures of the afferent unit.

The most important part of the third functional unit of higher forms of congnitive activity connected with speech – perception organized into logical schemes, active verbal memory, logical though – whereas the right – non dominant – hemisphere either begins to play a subordinate role in the cerebral organization of these processes or play no part whatsoever in their course. This principle of localization of higher functions in the cerebral cortex begins to operate only with transition to the secondary and, in particular, to the tertiary zones, which are principally connected with the coding –or functional organization – of information reaching the cortex, and performed in the man with the aid of speech. It is for that reason that the functions of the secondary and tertiary zones of the left – dominant – hemisphere start to differ radically from the functions of the secondary and tertiary zones of right – non – dominant – hemisphere : the leading role of the left – dominant – hemisphere, like the principle of progressive lateralization of functions, sharply distinguishes the organization of the human brain from that of animals, whose behaviour is not organized with the close participation of speech activity. This is one of the most important features distinguishing of the human brain as the organ of this mental activity.

However, it must be remembered that the absolute dominance of one – the left – hemisphere is not by any means always found, and the law of lateralizations is only relative in character. "According to recent investigations .... only one – quarter of all persons are completely right – handed, and slightly more than one – third showed marked dominance of the left hemisphere, whereas the rest are distinguished by relatively dominance of the left hemisphere, and in one –

tenth of all cases the dominance of the left hemisphere is totally absent..." (1)

Let us now birefly summerize what has been said concerning the second functional system of the cerebral cortex, which is a system of reception, coding and storage of information. It is located in the posterior divisions of the cerebral hemispheres and it incorporates visual - occipital -, auditory (temporal) and general - parietal - regions of the cortex: The organizations of the structures of this unit are hierarchical for they are subdivided into primary - projection - areas, receiving the corresponding information and analysing it into its elementary components and secondary (projection - association) areas, responsible for the coding - synthesis - of these elements and converting somatotopical projections into functional organization, and the tertiary zones - zones of overlapping, - responsible for concerted working of the various analysers and the production of supramodal - symbolic - schemes, the basis for complex forms of gnostic activity.

So far we have been examining the work of the zones of the cerebral cortex which form the second functional unit of the brain and participate in the reception analysis and storage of information. We must now turn to these systems of the brain which prepare and carry out of the function of movement. In the early stages of mammalian development, the cortical systems preparing for movement were not so clearly subdivided between two units, and single sensorimotor region, consisting of afferent - kinesthetic - cells and motor

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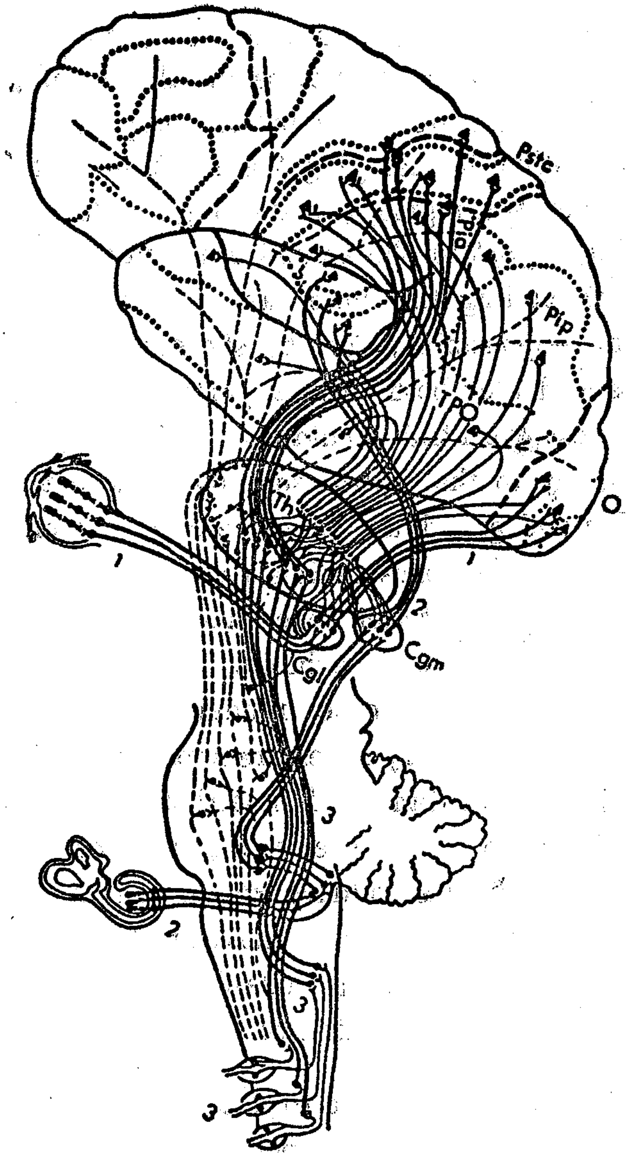
(1) Ibid., PP. 78—79.



Scheme of the cortical-subcortical relationships of the primary, secondary, and tertiary zones. The thick lines indicate systems of analyzers with their relays in the subcortical divisions. (1) Visual analyzer; (2) auditory analyzer; (3) cutaneokinesthetic analyzer. (T) Temporal region; (O) occipital region; (Pip) Area 39; (Pia) Area 40; (Pstc) postcentral region; (TPO) temporo-parietal-occipital subregion; (Th) thalamus; (Cgm) medial geniculate body; (Cgl) lateral geniculate body. (After Polyakov.)

cells proper could be distinguished in the cortex. In the late stages of development, in primates and, in particular, in man, differentiation took place and the two parts of the functionaly single system, one for the preparation of movements and the other for carrying them out, became separated into the post central region, maintaining its afferent functions and forming a part of the second brain unit, while the anterior zones, including the motor and premotor areas, took over special responsibility for the efferent organization of movements and they both form a part of the third brain unit. The post central – cutaneo – Kines – thetic – zones is posteriorly to the central sulcus and have the typical parvo cellular and grandular structure of the second brain system. In the primary zones of this region – Brodmann's area 3, – just as in all projection zones, afferent layer IV of the cortex is predominant, and exhibits a clearly somatotopical structure. Just as other modally specific zones of this brain unit, secondary zones are superposed above the primary – projection – cutaneo – Kinaesthetic cortex. These zones comprise Brodmann's, area 3, and part of areas 7 and 40, in which the other secondary zones, the upper layers of the cortex begin to occupy a substantial place and which, although perceiving their modally specific character, lose the somatotopical organization of their parts.

An essential feature of the premotor zones is that it becomes powerfully developed only in the last stages of the evolution of mammals, whereas in lower monkeys the primary motor area (area 4) is sharply predominant and the premotor cortical zones (area 6) occupy only an insignificant place, in man these relationships are reversed, and the premotor cortex occupies the greater part of the precentral region. "According to the Moscow Brain Institute in the primary motor area (Brodmann's area 4) a much large number of cells is concentrated in the cortical layer V – the effector layer – whereas there are comparatively few cells in layers II and III: the associat-analysers. Meanwhile, in the secondary, premotor zones of the motor cortex (Brodmann's area 6) the number of cells in the upper layer of the cortex rises sharply, and the number of cells in the same layers in the still more complex tertiary zones (Brodmann's area 10) is even greater. These results .. demonstrate this situation and reflect the increasing role of the premotor, and then of the prefrontal zones of the organization of the complex human motor behaviour". (1)

With the description of the functions of the motor cortex we have in fact began the detailed analysis of the functional organization of the third principal brain unit: the one responsible for programming, regulation and verification of of human activity. The frontal lobes and, in particular, their tertiary formulations (including the prefrontal cortex) were the latest parts of the cerebral hemisphere to be formed, and that while they are hardly visible in lower animals, they become appreciably larger in primates, and in man they occupy up to one quarter of the total mass of the cerebral hamispheres, but they do not obtain maturity in the child until between four and seven years of age. The frontal zones, or the frontal granular cortex, consist entirely of cells of the upper-associative layers of the cortex and they have the richest connections both with the upper parts of the brain stem and thalamatic structures and with all cortical zones.

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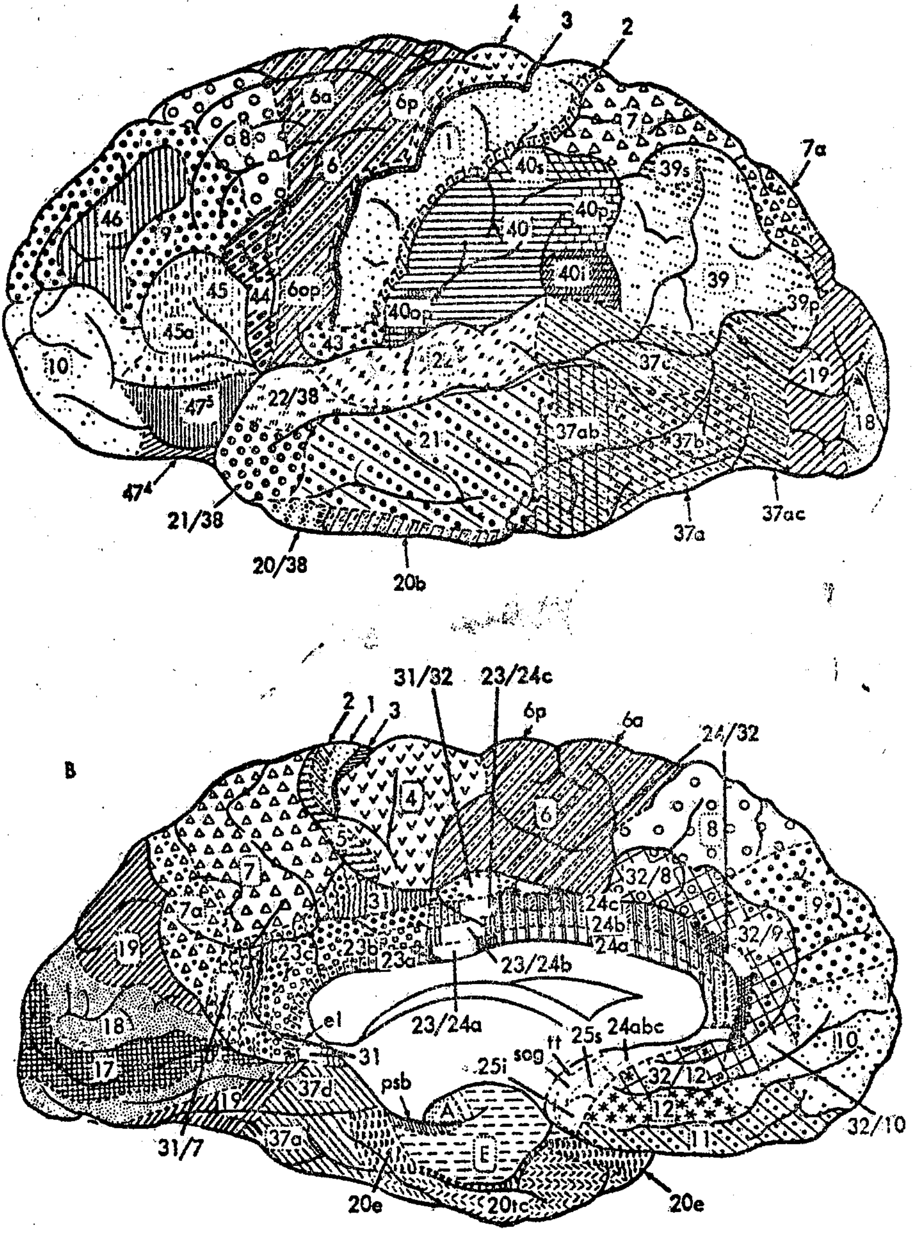
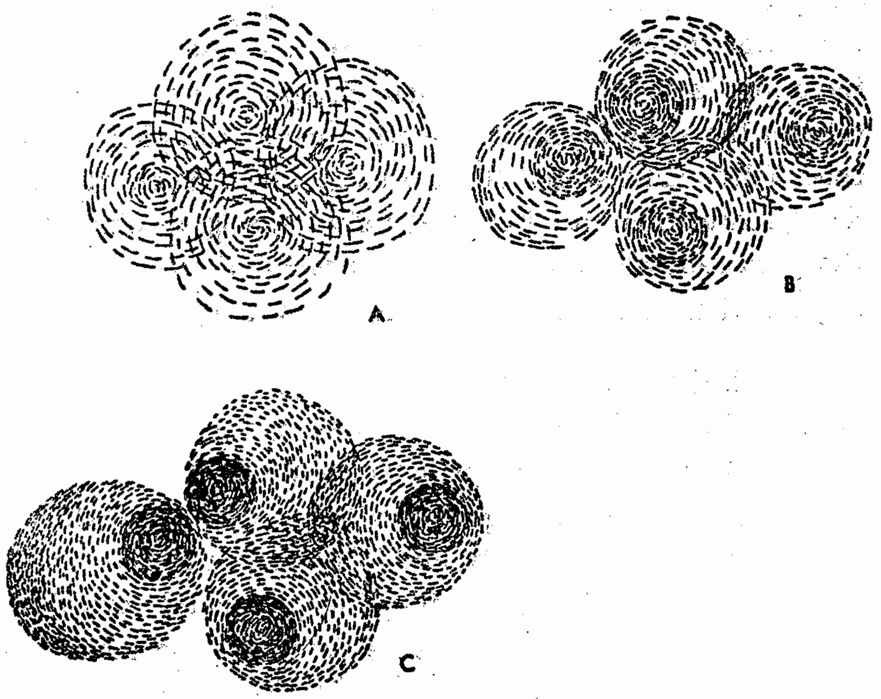
(1) Ibid., P. 178.



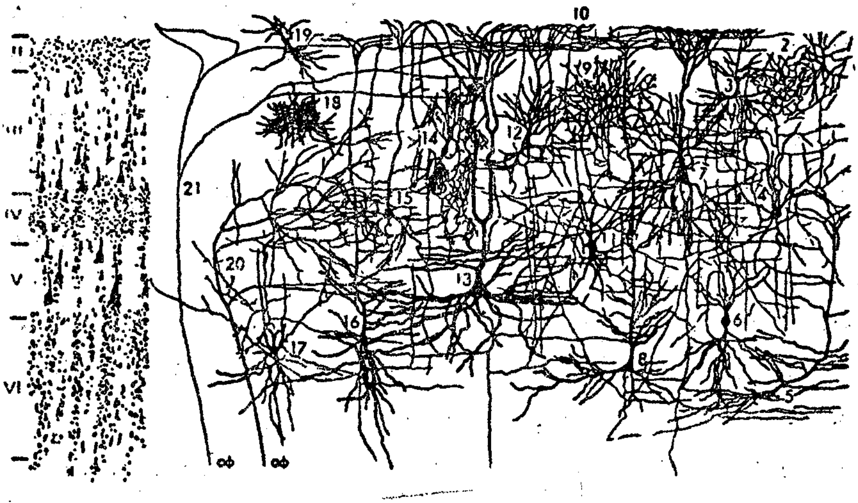
Scheme of the cytoarchitectonic fields of the cerebral cortex(a) convex surface of the cortex (b) Medial surface of the cortex, (Based on the records of the Moscow Brain institute.)



Schems. of differentiation of the primary, secondary, and tertiary fields of the cortex in a series of mammals, (A) insectivores, (B) Carnivores and ungulates. (C) Primates and man. The progressive differentiation of the primary (central) fields (denoted by dark shading) is indicated, as well as the growth of the peripheral (secondary) fields of the nuclear zones (denoted by light shading) and the formation of the tertiary fields (overlapping zones). (After polyakov.)

Thus, they are superposed not only over the secondary zones of the motor cortex but also, in fact, over all the other formations of the brain. Therefore, they possess lateral connections both with the lower parts of the reticular formation, which modulates cortical tone, and also with the formations of the second brain unit which is responsible for the reception, analysis and storage of information, enabling the prefrontal zones to control both the general state of the cerebral cortex and the course of the fundamental forms of human mental activity. In view of these two important functions of the frontal lobes it is perfectly logical to regard these structures as tertiary for the limbic system, on the one hand, and for the motor cortex on the other. These functions also enable us to understand the impartant role of the frontal lobe in the regulation of viligance and in the control of the most complex forms of man's goal-linked activity. We shall now examine these two functions separately.

For any mental process to take place, a certain level of cortical tone is necessary and this cortical tone must be modified in accordance both with the task to be accomplished and the stage of the activity reached. The first important function of the frontal lobes is to regulate this state of activity. Each state of active expectency arous characteristic slow waves in the frontal regions of the brain, which Gray Walter has described as "expectency wave" and that every active intellectual activity leads to the appearance of large number of simultaneously working excited parts. These facts are evidently closely connected with the activating role of speech which formulates the problem or provides the special



Scheme of the neuronal and architectonic structure of the cerebral cortex. The cytoarchitectonic layers of the cortex are shown on the left and the various shapes of the cortical neurons (pyramidal, fusiform, and stellate) on the right (After Polyakov. 1959).

the brain is the frontal labes or, to be more prices, the prefrontal divisions of the brain. It is these portions of the brain, belonging to the tertiary zones of the cortex, which play a decisive role in the formation of intention and programmes, and in regulation and verification of the most complex forms of human behaviour. A distinguished feature of the prefrontal region of the brain is that it has a very rich system of connections both with the lower levels of the brain and with virtually all other parts of the cortex. These connections are two - way in character and the prefrontal divisions of the cortex structures they make are in a particular favourable position both for the reception and synthesis of the complex system of afferent impulses arising from all parts of the brain and for the organization of different impulses, so that they can regulate all these structures. It is important to note that the frontal lobes and, in particula their medial and basal portions are connected by particularly well-developed bundles of ascending and descending fibers with the reticular formation, and that these regions of the new cortex receive particularly poweful streams of impulses from the systems of the first functional unit of the brain by which they are charged to the appropriate energy one, on the one hand, and, on the other hand, they can have a particularly powerful modalling influence on the raticular formation, giving its activating impulses, their differential character, and making them conform to the dynamic schemes of behaviour which are directly formed with the frontal cortex.

The prefrontal regions of the cortex do not mature until very late in ontogeny, and not until the child reached the age of four to seven years do they become finally prepared for action. This fact is clear from the successive increase in area occupied by the prefrontal divisions of the cortex in ontogeny and also from the rate of development in the size of the constituent nerve cells. The rate of the increase in area of the frontal regions of the brain rises sharply by the age of the three and half to four years, and this is followed by a second jump towards the age of seven to eight years. The prefrontal division of the brain, which undergo powerful development in the later stages of evolution and which, in man, occupy up to one – quarter of the total mass of the brain, also have other functions more directly connected with the organization of human activity and they have two-way connections not only with the lower structure of the brain stem and diencephalon, but also with virtually all other parts of the cerebral cortex. Thus, this is conclusive evidence that the prefrontal regions of the brain are tertiary cortical structures, and are in intimate connections with nearly every other principal zone of the cortex. If it were necessary to mention any particular feature distinguishing the prefrontal regions of the brain from the tertiary zones of the posterior regions, it would be that the tertiary portions of the frontal lobes are in fact a superstructure above all other parts of the cerebral cortex, so that they perform a far more universal function of the general regulation of the behaviour than that performed by the posterior associative cortex, or, in other words, the tertiary areas of the second brain unit previously mentioned .

The observations of Pribram(1) have shown that an animal

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(1) Pribram, K.H., "The Effect of Prefrontal Lesions on the Behaviour of Monkeys" in Pribram, K.H., editor, Brain and Behaviour, London, Penguin, 1969, PP. 439—458.

with intact frontal lobes can tolerate long pauses while awating appropriate reinforcement, that its active responses are strengthened only with the approach of the time when the expected stimulus should appear; by contrast an animal deprived of its frontal lobes cannot maintain such a state of active anticipation. It can thus be concluded that the frontal lobes of the brain are among the vital structures responsible for the orientation of an animal's behaviour not only to the present, but also to the future, and that, therefore, responsible for the most complex forms of active behaviour.

Finally, attention must be drawn to yet another important function of the frontal lobes. As a result of recent work, it can no longer be held that the scheme of the reflex arc can adequately reflect all that is essential in the structure of behaviour, but it must be replaced by the scheme of a reflex ring or reflex circle in which, besides reception and analysis of the stimuli from the external environment, and a response to these, it is also necessary to take into account the reverse influence which the action has on the animals brain. This feedback mechanism or reverse afferentation, as an essential component of an organized action, has been closely studied by several Soviet investingators, and it has been described by Anokhin as the action acceptor(1) apparatus, without which any form of organized action is impossible. Numerous observations show that the most complex forms of this action

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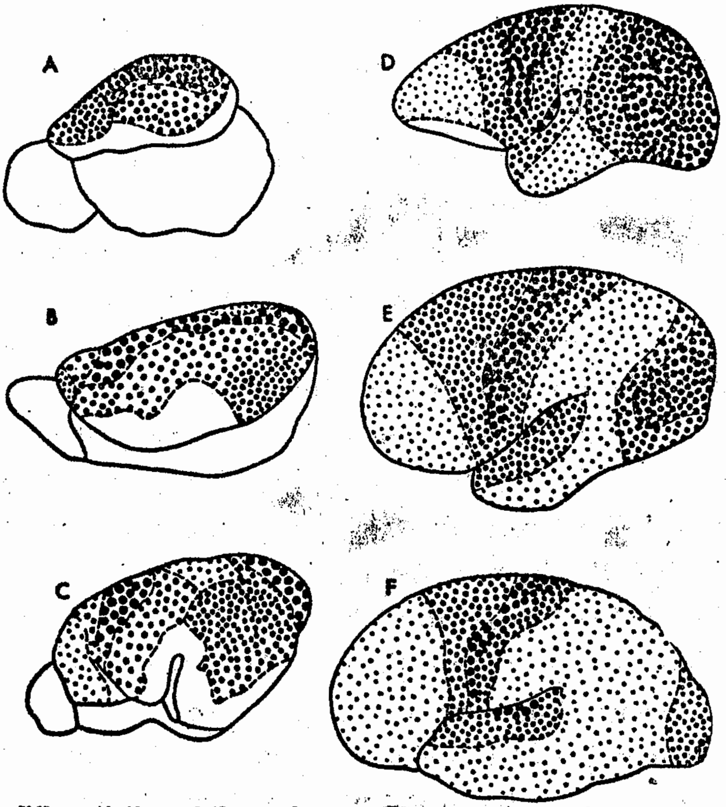
(1) Anokhin, P.K., "Electro-encephalographic Analysis of the Conditioned Reflex" in Pribram, K.H., editor, Brain and Behaviour, London, Penguin, 1969, Vol. 3, PP. 130—181.

acceptor are associated with the frontal lobes, and that the frontal lobes not only perform the functions of synthesis of external stimuli, perception for action, and formation of programmes, but also the function of allowing for the effect of the action carried out and verification that it has taken the proper course. Thus, the time has passed when it was thought that mental processes could be represented by modals of a reflex arc the first part of which was purely afferent in character and performed the function of sensation and perception, while the second, affector part, was entirely concerned with the movement and action, Modern views, as alseady stated, are completely different in character and are based more on the modal of reflex ring or self regulating system, each component of which embodied both afferent and effector elements, so that on the whole, mental activity assumes a complex and active character. It is also necessary to stress again that the human frontal lobes are much more highly developed than the frontal lobes even of the higher monkeys; and that is why in man, through the progressive corticalization of mental functions processes of programming, regulation and varification of conscious activity are dependent to a far greater extent on the prefrontal parts of the brain than the processes of regulation of behaviour are in animals. This principle is true also in ontogeny.

Let us assume that a brain has been removed from its cranium and placed on a small glass table before us. What we see is a grey mass ridged throughout with furrows and raised convolutions. This mass is divided into two hemispheres, left, and right, connected by a thick, callous, ligament. Superficially this matter – the cortex of the large hemispheres



Progressive differentiation of the regions and fields of the cerebral cortex. (A) Brain of the hedgehog. (B) Brain of the rat. (C) Brain of the dog. (D) Brain of a lower ape. (E) Brain of a higher ape. (F) Human brain. The large dots denote the primary (central) fields of the nuclear zones; the middle-sized dots denote the peripheral (secondary) fields of the nuclear zones; the small dots denote the teriary fields (overlapping zones.) (After Polyakov.)

is of an even grey colour though less than four or five mellimeters thick, it consits of an enormous number of nerve cel's that form the material basis for all complex psychological processes. The cortex of the outer sections of the hemispheres. is of more recent origin than that of the interior parts. Just below the thin layer of the cortex is the white matter, which is composed of multitude of closely connected fibers that join separate parts of the cortex, conduct to it stimuli originating at the periphery, and redirect to the periphery reactions that develop in the cortex. On a still deeper level additional sections of gray matter are to be found; these form the subcortical nuclei of the brain, the oldest and most recessed mechamisms of the brain – stations at which stimuli from the periphery terminate and undergo their initial processing.

The brain appears to be uniform and monotonous, but it is the highest product of evolution. It receives, processes, and retains information, sets up programmes of behaviour, and regulates their execution. Obviously the superficial impression one has of the brain as a uniform, undifferentiated gray mass is diametrically opposed to the unconceivable complexity and differentiation this organ actually possesses. The gray matter consists of an extraordinary number of nerve cells, neurons, the fundamental units of brain activity. Some scientists estimate that there are about 14 billion of these; others assume the total is even higher. More importantly, these neurons have a strict pattern of organization: individual areas or blocks differ radically in function. The first of these formations, as already stressed, might be called the energizing or tonus – regulating block; . It is located at the base of the brain within the upper sections of the brain stem, and in the reticular formation that constitutes the starting point for the brain vital activity. Part of this block, located up from without, is powerless to convert these into a set of symbols to control its behaviour. And it has within the depths of these masses of gray matter what the ancient termed the visual bumpoptic thalamus – though it actually has only a remote connection with visual processes. It is a preliminary station for processing impulses stemming from both metabolic functions in the organism and excitation of the sensory organs. When these impulses, in turn, are coducted to the cerebral cortex, they impart to its normal state of tonicity and vigour. If the influx of these impulses ceases, the cortex loses its tonicity, the person lapses into a semisomnolent state, and then into sleep. This mechanism feeds the brain just as a power source provides for the feedings of electronic devices.

The second major block of the brain, located in the posterior sections of the large hemispheres, performs a most important function. The function of this block is not to guarantee the vigour of the cortex, but rather to act as a block for receiving, processing, and retaining information a person derives from the external world. A person perceives thousands of objects, both familiar and unfamiliar. He picks up an endless number of signals from his environment. This section of the cortex, includes, for instance, the primary visual cortex – located in the hindmost part of the occipital region, – is indeed a remarkable laboratory that breaks down images of the external world into millions of costituent parts. Adjacent to this area is another section of the occipital region that specialists term the secondary visual cortex. Distributed throughout the upper layers of the cerebral cortex, the entire mass of this cortex consisting of tiny nerve cells with short offshots combine stimuli transmitted to them from the primary visual cortex into complete and intricate complexes – dynamic patterns. They convert the individual features of objects perceived into complete, manifold structures. This part of the brain operates as a device for processing and retaining information, as previously stated.

Naturally, other, more complex sectors of the cerebral cortex affect our simultaneous grasp of spacial relationships. These sectors are adjacent to the occipital parietal, and temporal areas and constitute one of the mechanisms of the tertiary cognitive part of the cortex – at the point it could be termed the gnostic part – . The function of the later is to combine the visual – occipital, – tactile – motor (parietal), and auditory – vestibular (temporal) sections of the brain. These sections are the most complex formations in the second block of the human brain. In the process of evolution, as already stressed, they were the last part of the brain to develop, and only in man did they acquire any vigour. They are not even fully developed in the human infant but mature gradually and become effective by ages four to seven. They are extremely vulnerable and even a slight impairment disturbs their function. Since they consist entirely of highly complex associative cells, many specialists term them zones of convergence for the visual, tactile – motor, and auditory – vestibular parts of the brain. The tertiary regions of the parieto-occipito – temporal of the left hemisphere are intricately linked to one of the most important psychological functions –namely, language which is not simply a means of communication but also a crucial part of the entire process of cognition. We use words to designate objects and their location in space – right, left, behind, in front of, etc... Through grammatical constructions we express relationships and ideas. A part from being a means of communication, language is fundamental to perception, and memory, thinking and behaviour. It organizes our inner life.

The third block is located in the anterior section of the brain, and includes the frontal lobes. It does not effect the tonicity of the cortex; neither does it receive, process, or retain information from the physical world. It is linked to the world solely by means of mechanisms in the second block, and it can function effectively only if the first block has kept the cortex sufficiently nourished and vigorous. The function of this third block is decisively important; it is a powerful apparatus that allows one to form and sustain – intentions, plan actions and carry them through. An injury to these anterior sectors of the brain – including the frontal lobes – does not damage a person's capacity to learn, perceives, or remembers. His world remains intact, though his life is indeed pathetic: he is completely unable to form any lasting intentions, plan for the future, or determine the course of his own behaviour. He can only respond to signals he picks, no possibility of evaluating his shorcomings, he cannot correct them; he is robbed of any possibility of a future and loses precisely what it is that makes a person human.

In the light of what has been said so far in this section it is clear that all mental processes – perception, memory, thinking, language, attention, imagination, writing, reading, counting, etc. – cannot be regarded as isolated or even individually processes which can presumed to be direct functions of limited cell groups which are to be localized in particular areas of the brain. They are complex functional systems formed in the course of long historical development, social in origin, complex and hierarchical in their structure. Two factors, which sharply distinguish the form of the work of human brain from the more elementary forms of the work of the animal brain, are perhaps the most essential features of this new concept of localization of mental proceses in the cortex. Whereas higher forms of human psychological activity are always based on certain external mechamism – good examples are the knote which tie in our handkerchiefs, for instance, to remember something essential, a combination of letters which we write so as not to forget an idea, or a multiplication table which we use for aritmatical operations – it becomes perfectly clear that these external aids of historically formed devices are external elements in the establishment of functional connections between the individual parts of the brain, and that by their aid, areas of the brain which previously were independent become the components of a single functional system. This can be expressed more vividly by saying that the hierarchically formed measures for the organization of the human behaviour tie new knotes in the activity of man's brain, and it is the presence of these functional knots or, new functional organs, that is one of the most important features distinguishing the functional organization of the human brain from an animal brain. In this principle of construction of the functional systems of the human brain that Vygotsky(¹) called the principle of extracortical organization of the complex mental functions, implying by this somewhat unusual term that all types of human conscious activity are always formed with the support of external auxiliary tools or aids. The second distinguishing feature of the localization of higher mental functions in the human cortex is that it is never static or constant, but move about essentially during development of the child and at subsequent stages of training. This preposition, which at first glance may appear strange, is in fact quite natural. The development of any type of complex conscious activity at first is expanded in character and requires a number of external aids for its performance, and not until later does it gradually become condensed and converted into a distinct mental skill.

In the initial stage of writing, which is a simple mental function, for example, writing, depends on memorising the graphic form of every letter. It takes place through a chain of isolated motor impulses, each of which is responsible for the performance of only one element of the graphic structure with practice, this structure of the process is radically altered and writing is converted into a single kinetic melody,no longer requiring the memorizing visual form of each isolated letter or individual motor impulses for making every stroke. In the course of such development it is not only the functional structure of the process which changes, but also,

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(1) Vygotsky, L.S. "Higher Mental Functions" in Luria, A.R., editor, Psychological Research in the USSR, Moscow, Mir Pub., 1966, PP. 7—36.

naturally, cerebral organization. However, the development of higher mental functions in ontogeny has yet another feature of decisive importance for their functional organization in the cerebral cortex since during ontogeny it is not only the structure of higher mental processes which changes, but also their relationship with each other, or, in other words, their interfunctional organization. Whereas in the first stages of development a complex mental activity rests on more elementary basis and depends upon a basal function in subsequent stages of development it not only acquires a more complex structure, but also starts to be performed with the close participation of structurally higher formations of activity. For instances, the young child thinks in terms of visual forms of perception and memory or, in other words, he thinks by recollection. At later stages of adolescence or in adult life, abstract thinking with the aid of the functions of abstraction and generalization is so highly developed that even relatively simple processes such as perception and memory are converted into complex forms of logical analysis and synthesis, and the person actually begins to perceive or recollect by reflection.

Since the systems of analysers, or the elements of the brain, previously described, play the decisive role in the formation of human psychological processes, it is highly esential to detail their structure and functions and elucidate their evolution in the animals kingdom in the light of the latest findings of the oustanding Soviet neurologist Poliakov, ⁽¹⁾. However,

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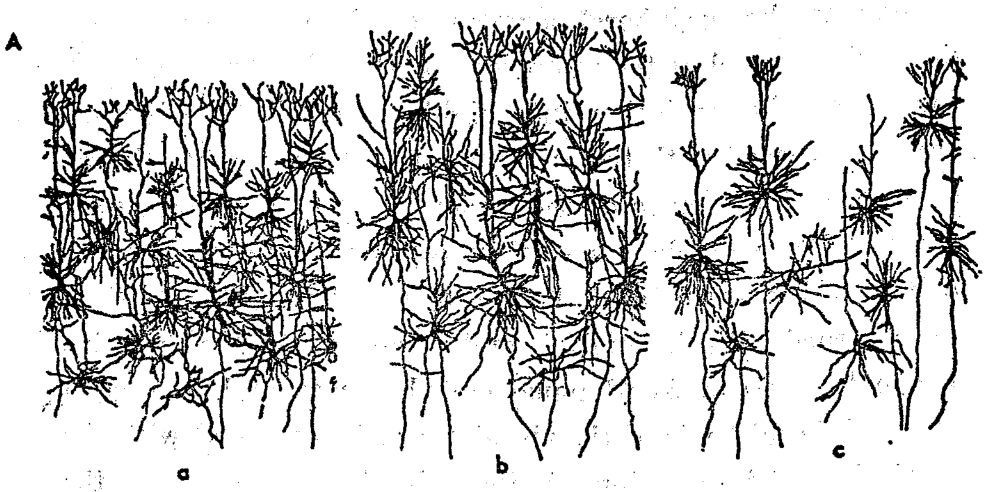
(1) Poliakov, G.I., On the Neuronal Organization of the Brain, Moscow, Mir Pub. 1971.

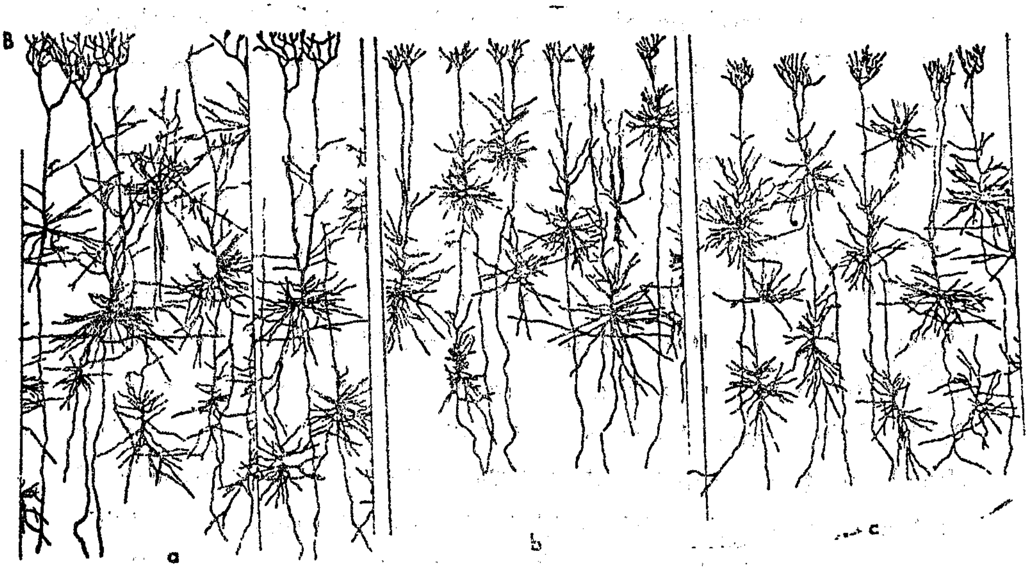
before so doing it is necessary to stress, that, as we shall see latter, the term "analysers" employed by Pavlov to describe what were previously known as sense organs.

The qualitative complication of the arrangements connected with the extension of the organism's orientation in the world around it and the far-reaching transformations of the whole sphere of its receptive activity, is the development of the analysers. The physiological significance of the evolution of these sections of the whole reflex apparatus is that they entble the organism to differentiate among the host of the less important side – stimuli apart from those directly processed by the coordination mechanism, and ensure the adaptation to the environment vital to its existence. The outsome is that the organism is placed in a position to react selectively to a variety of signals of a significance far beyond what is required for its direct security. In the more highly organized members of the animal kingdom the highest, cerebral ends of the analyser systems lie in specific regions of the cerebral hemispheres. These cerebral parts of the analysers are specialized for certain processes of analysis and synthesis of stimuli, not simply to their physical and chemical parameters, but also, and mainly, according to their signal significance for the life of the organism. The highest level of their development and perfection is achieved in the cortical formations of the primates and in man among the primates. Analysis and synthesis of stimulation are necessary preconditions of the ordered reflex activity at any stage of its phylogentic evolution and are manifested differently depending on the relations between their development. At the low levels of the evolution of the analysers the results of the primitive analysis of stimulation are utilized for the instinctive behaviour or the auto-controlled activity, and higher at the higher levels for a more varied and flexible behaviour. It is typical of the behaviour of the lower forms of the animal life, in contrast to the higher ones, is that it is not only conditioned by the existing stimulation but also determined by it to a considerable degree – or even completely– . In other words, the lower animal can make prediction about the probable future and program its behaviour only to a very insignificant extent owing to the low level of the development of its analysers. The reverse is the case in the higher animals reaching its highest degree in man.

In the lower mammals only a few of the principal analyser zones – visual, auditory, cutaneo – Kinesthetic, – although not yet differentiated internally into fields and only very indistinctly denarcated from each other, can be distinguished. At the higher stage of mammalian evolution, the nuclear zones of the analysers in the posterior part of the hemisphere are more clearly demarcated and there is differentiation into central and peripheral fields. Parallel with this process, there is an increasing tendency for one zone to extend into another, with the formation of overlapping zones – or tertiary zones previously outlined, – because of intensive growth of the nuclear zones over the surface of the hemispheres. These zones are still weakly defined in the carnivores and ungulates, but are clearly distinguishable in primates – . In the anterior parts of the hemispheres progressive cortical differentiation gives rise to a distinct motor zones of the cortex, subsequently dividing into motor and premotor fields, and to the intensive growth of the area occupied by the fields of the frontal region proper. In the anthropoid apes nearly all fields present in man can be distinguished, but only in man is the qualitative differentiation of the structure of these fields perfected and their final topo-graphical relationships established. In man the territory occupied by the tertiary fields grows enormously to cover half of the total surface area of the cortex. Parallel with this growth, the area of the peripheral fields compared with that of the central fields, wich occupy a relatively small area in man, increases sharply, and in absolute terms, these central fields, too, are much more extensive than in monkeys. These three groups of fields – the primary, secondary and tertiary, already specified, arise in a definite order during both mammalian evolution and the individual development: phylogeny and ontogeny. The central fields appeare first and can be identified by their different architectonics and neuronal structure, and the differences develop to both in phylogenesis and in prenatal ontogenesis. The latest of all to mature are the overlapping zones of the analysers and the formations of the frontal regions. This process occupies the few years of life. The connections of these cortical areas are also the last to complete their cycle of development. The important transformations of the cortical organization caused by the appearance of the second signal system associated with man's productive activity – speech, thought which are a specially human feature. The transformations referred to affect all the groups of cortical fields that have been under consideration. They are especially marked in relation to secondary and tertiary cortical fields. It is only in man, in the peripheral segments of the nuclear zones of the analysers and of the motor cortex, that the structural and functional differentiation into highly specialized, distinct areas, concerned with the analysis and integration of stimuli of especial importance of the various aspects of speech, took place. For example, a special area in the posterior segment of the peripheral field of the auditory cortex – Wernicke's – is concerned with the analysis and integration of the receptive elements of the spoken language or phonemes, and an area in the peripheral fields of the visual cortex is concerned with the analysis and integration of the visual elements of the receptive language. In the areas of the inferior segments of the parietal region, situated next to the cutaneo – kinesthatic reception fundamental to the articulation takes place. A certain portion of the periphery of the motor cortex, the inferior segments of the premotor zone – Broca's centre – is the seat of neurodynamic processes involved in the synthesis of the individual sounds of the spoken speech into complex, structure units. In another portion of the premotor zone, adjoining the motor apparatus of the upper limb - in the posterior segment of the mid – frontal gyrus, – are located at the cortical mechanisms for programming and performance of the complex systems of successive movements and motor skills. As a result of the segregation of the specialized areas of the nuclear zones, the neuronal structure of the cerebral fields of these zones become perfected and capable of perceiving the elements of speech and of differentiating their sensory and motor components with a high degree of precision. This process is particularly conspicuous in the central auditory field. In man this field is much extensive than in monkeys,



20 Illustrations of the relative widths of the neuronal structure of the primary, secondary, and tertiary fields of the cortex, showing decreasing width from primary to tertiary fields, (A) Neuronal structure of the fields of the posterior divisions of the hemisphere; (a) Primary field of the postcentral region; (b) secondary field of the postcentral region; (c) tertiary field (inferior parietal region).



(B) Neuronal structure of the fields of the anterior divisions of the hemisphare; (a) Primary giant pyramidal field ,motor area): (b) secondray field (premotor area); (c) tertiary field (frontal region). (After Polyakov.)

both absolutely and relatively, and has undergone further differentiation into a series of subsidiary fields. The progressive structural changes reflect the fundamental role of the spoken language in the entire system of verbral communication.

The upshot of the qualitative transformation undergone by the overlapping zones of the analysers in the frontal portion of the cortex following the formation of the second signal system is that all of man's conscious processes, governing his action, involve the participation of the system of verbal communication and, indeed, are under its domination. Generally speaking. "with the differentiation and qualitative specialization of the elements of all the layers in the course of mammalian phylogenesis, in particular that of primates, layer III of the cortex became especially well developed, and its neurons send, receive and analyze the greater of the associative impulses of the cortex. The width of this layer gradually icreases from the lower to the higher members of primates, and its divisions into sublayers becomes increasingly evident. A similar process takes place throughout ontogenesis."(1)

The concept of analysers was introduced in physiology by Pavlov in 1909. The study of the activities of analysers has great theoretical and practical significance for physiology, philosophy, pedagogy and medicine. It is also important for technological progress, in planning of which the study of analysers is concerned with engineering psychology. In biology, the concept of analyers denotes the complex anatomical-physiological systems that provide for perception and analysis, of analysis of all stimuli acting on animals and humans. The biological role of analysers is to ensure the expedient reation of an organism to a change in its more complex adaptation to the surrounding world and the maintenance of a relative constancy in its internal environment. Every analyser consists of peripheral receptive apparatus (receptor), the conducting part of the analyser – which transmits information – and the higher centre of the analyser: a group of neurons in the cerebral cortex.

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(1) Luria, A.R., Higher cortical Functions in Man, London, Tavistock, 1966, P., 63.

Analysis of stimuli acting on the organism begins at the periphery. Each receptor reacts to a definite form of energy. Analysis continues in the inter brain neurons. Thus distinguishing the color and position of an object is possible at the level of the neurons of the visual analyser located in the interbrain. But subtle, differentiated analysis of complex, changing stimuli from the external environment takes place only in the highest centres of the analyser: the cortex of the large hemispheres of the brain. The analyser function of the brain of animals and humans is in close mutual interaction with their synthetic function and its characterized by great sensitivity, subtle differentiation of perceptions and broad adaptation to changes in intensity and quality of stimuli. The analytic-synthetic activity of the large hemispheres of the brain is the basis of higher nervous activity.

The cerebral cortex is a dynamic association of formations, distinguished by their high plasticity, unification into mobile, dynamic complexes, and joint participation, in varying degress, in the various stages of the foundation, development and perfection of the different forms of cortical activity. The reflex principle is the basis of theory of comprehensive multistage localization of functions, and the various fields of the cortex together with their systems of connections are highly specialized elements of a functionally single but structurally complex entity. The cerebral cortex, the most highly organized part of the entire nervous system, has come to be regarded as a higher-level for analysis and integration of signals received by the organism form its internal and external environment. This is based on Pavlov's fundamental idea of the systems of analysers and of nuclear zones of the analysers in the cerebral cortex. The meaning of the term "nuclear zones" is, from the point of view of Pavlov, is the particular zones of the cortex in which the concentration of the specific elements of the analysers in the cerebral cortex and their corresponding connections is maximal. Pavlov. regarded these zones as being associated with the most highly differentiated manifestation of the activity of the individual analysers yet, at the same time, carrying out an integrative function. In contrast to the nuclear elemens, closely inter-connected and capable of performing the most complex analysis and integrations of specific stimuli, Pavlov postulated the existence of weak elements outside the nuclear zones. And the term "analysers", as already mentioned, was introduced by Pavlov, in the place of the designation "sense organs", to denote the whole analying apparatus of the nervous system, e.g. the accoustic, visual, etc. analysers. It covers not only the peripheral receptor with all its afferent neurons but also the nerve cells which lie at the central termination of the nerve fields, in the cortex, and must each be related to some definite element of some definite form of energy. Pavlov also regarded the motor region of the cortex as an analyser of impulses from the muscles and joints.

"We may thus conclude that the occipital region of the cortex – Brodmann's areas 17, 18 and 19 – is the nuclear zones of the optic analyser, that the superior subregion – areas 41, 21 and 22 – is the nuclear zone of the auditory analyers, and that the postcentral region – area 3, 1, and 2 – is the nuclear zone of the cutaneous – kinesthetic analyser. Clinical observations ... have shown that injury to different fields of the cortical nucleus of any analyser gives rise to very different clinical pictures. One field, centrally placed in the nuclear zone, stands out from the rest. This central or primary field consists of area 17 in the visual zone, area 41, in the auditory zone and area 3 in the cut-neous kinesthetic zone. It is after injury in these central areas that the most marked manifestations of the decrease in the power of direct perception and accurate differentiation of the corresponding stimuli .... appear ... The central fields of the nuclear zones are sharply distinguished by their unique cytoarchitectonic picture. The small grandular cells of the layer IV, relaying impulses arising via the powerfully developed projection fibers from the subcortical divisions of the analysers to the pyramidal neurons of the layer III and V of the cortex, are particularly numerous in these fields". (1) It is clear from what

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(1) Luria, A.R., Higher Cortical Functions In Man, London, Tavistock, 1966, P.P. 44—45.

has been said so far that the primary fields of the nuclear zones in man are highly specialized areas of the cortex, capable of minute differentiation of stimuli: that is an indispensable property for the integrated perception of complex groups of stimuli reflecting the diversity of the outside world.

The peripheral or sensory fields, situated in the peripheral segments of the nuclear zones, show characteristic differences from the central or primary fields in their physiological manifistations and in the details of their arch itectonic and neural organization. The most prominent cytoarchitectonic features of the secondary fields of the cortical nuclear zones are those elements of their neuronal structure that are adapted for relaying the different impulses coming from the subcortex. The secondary fields of the nuclear zones play a highly important part in relaying the individual stimuli differentiated by the primary fields and in functionally integrating the nuclear zones of the different analysers and of the groups of impulses arising from the receptors in the different analysers. Hence, these fields are mainly involved with the relative motor complex forms of coordinated mental processes with detailed analysis of the relationship between concrete objective stimuli and with the orientation of relation to a correct spetial and temporal environment.

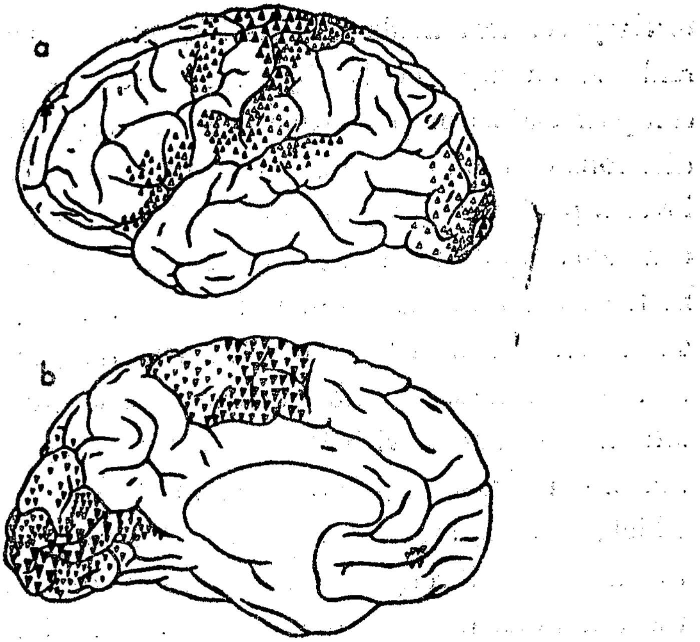
The increased complexity of the functional relationships between the analysers is reflected morphologically by the fact that with the progressive growth of the nuclear zones of the analysers over the surface of the hemispheres, overlapping zones of the cortical ending of the analyers – tertiary fields of the cortex are formed. These cortical formations, represented in the posterior portion of the hemispheres by the fields of the superior and interior parietal regions and of the mid-temporal and temporo-parietal occipital subregions, are associated with the most complex forms of integration of the conjoined activity of the visual, auditory, and cutaneo-kinesthetic analysers, since the tertiary fields of the cortex lie outside the nuclear zones proper, their injury or stimulation is not accompanied by any marked loss or modification of the specific functions of the analysers. As already stressed, the entire neuronal organization undergoes a definite change in the character with the transition from the entire neuronal organization that undergoes a definite change in the character with the transition to the secondary and from the secondary to the tertiary fields. The central cortical fields, which handle the most highly conncentrated streams of impulses and connect the cortex in the most direct manner with the sensory organs and peripheral motor organs are distinguishable from the other fields by the coarseness of their neuronal structure, which is adapted for the reception and return of intensive flows of excitation. It is the tertiary fields of the cortex that possess the finest neuronal structure, and this may be interpreted as the morphological expression of the particular precision and comptexity of the functional differentiation of these fields, which are responsible for the most highly specialized functional connections between the analysers. In this respect, as in all their charcteristics, the secondary fields are intermediate between the primary and tertiary fields.

In the course of human ontogenesis the difference between the structural differentiation of the fields in the posterior division of the hemispheres, principally responsible for the organization of the various forms of sensation and for the perception of external stimuli, and that of the fields in the anterior divisions of the hemispheres, principally responsible for the organization of actions, also sands out clearly. Starting with the early stages of the embryonic cortical development, the process of subdivision into layers and the formation of neurons with their connections are different – in different parts of the hemispheres. In the posterior part of the cortex the development of the layers proceeds according to a clear – cut typically six layered plan, with a separate, concentrated layer IV as the main receiver of afferent impulses from the subcrotical divisions of the analysers.

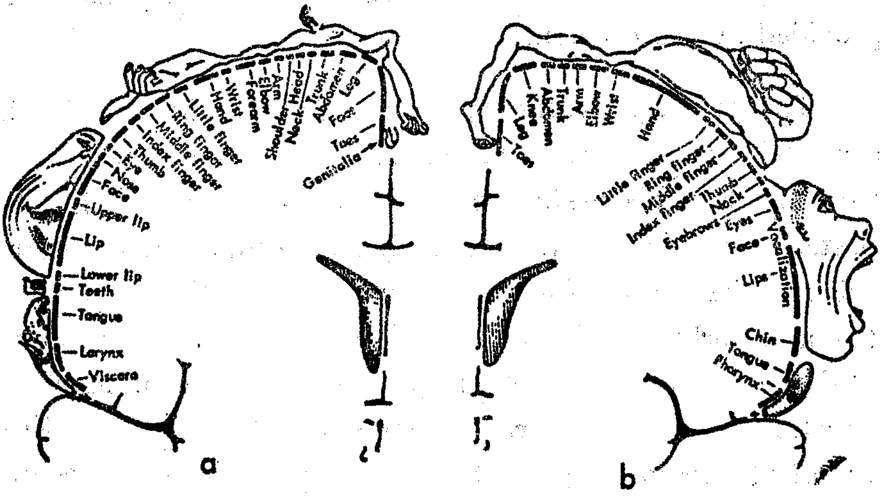
In contrast to the groups of neurons of the nuclear zones, the numorous groups of neurons composing the tertiary fields of the cortex are almost completely lacking in specific analyer functions, having made the complete functional transition to the adequate reflection of the most complex forms of spatial and temporal relationships between groups of actual stimuli and to the handling of these relationships during the organisms active response to the outside world.

The extensive area in man occupied by the overlapping zones of the cortical edings of the analysers is subdivided into a series of fields.

It seems justifiable to distinguish three special zones of overlapping, corresponding to the three superior parietal region, the inferior parietal region, and the tempero-parietal-occipital region. The two frontal regions are the most closely connected topographically and functionally with the zones of the cutaneo-kinesthetic and visual analysers, for it is between these zones they lie. The superior partietal region is bounded anteriory by those portions of the postcentral region in which the lower limbs and trunk are represented. This region is therefore particularly important for the integration of the movement of the whole body with the visual perception and for the formation of the body image. The interoparietal region is bounded by those parts of the post central region in which the upper limbs and face are represented. This region is therefore associated with the integration of the generalized and discrete forms of stimulation, with accurate and complex discrimination of objects and with the acts of speech, all performed under visual control and requiring a perfectly developed system of orientation towards the external environment. "Finally, clinical observation has shown that the tempero-partietal-occipital subregion, an area intermediate between the auditory and visual zones of the cortex, has an especially intimate functional relationship to the most complex forms of integration of auditory and visual reception, particularly in to the specific aspect of the semantics of the spoken and written language ... The most prominent feature of the architectonic and neuronal pattern of these ovelopping zones is the tertiary associative complex of the cortex represented by the pyramidal and stellated cells of the highest layers and sublayers of the cortex – the last to become differentiated in the evolution of the mammals, namely, the middle and upper sublayers of the layers III and II. The



Distribution of the large cells in Layers V and III on the surface of the hemispheres. The black triangles denote large cells in Layer V; the unshaded traiangles denote large cells in Sublayer III. (a) Lateral surface: (b) medial surface. (Modified from Bailey and Bonin, 1951.)



Scheme of the somatotopic projection in the cerebral cortex. (a) Cortical projection of sensation; (b) cortical projection of the motor system. The relative size of the organs reflects the area of the cerebral cortex from which the corresponding sensations and movements may be evoked. (After Penfield and Rasmussen, 1950.)

tertiary contical fields are distinguished from the primary and secondary fields by the presence of extremely complex claims of projection relays into the subcortical divisions of the analysers. In conformity with their high - level capacity of generalization and abstraction from actual, concrete stimuli, the tertiary cortical formations are connected in the most indirect manner, through the largest number of successive relays in the subcortex with the peripheral endings of the analysers. "The cortical overlapping zones from lateral connections with the publvinar group of the thalamus nuclei – the last to differentiate in the course of evolution – which, in turn, are connected with the relay nuclei proper of the thalamus through a complex chain of internal relays in the thalamus itself. Hence, impulses sent to these cortical areas from below undergo the most complex processing in the subcortex and are passed on to the cortex as integrated signals resulting from the interaction between the sensory messages provided by the different analysers". (1)

The primary, secondary and tertiary fields of the occipital, temporal and parietal regions of the cortex, which we have been discussing so far, are cocentrated in the posterior portion of the hemispheres, behind the central sulcus. The cortical fields of frontal lobe of the brain, situated anteriorly to this sulcus and including the precentral region and the frontal region proper, have a number of functional and structural features that distinguish them essentially from the part of the cortex posterior to the central sulcus. In principle, we can distinguish the same three

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(1) Ibid, P. 53.

main groups of fields in the frontal lobe of the brain as in the regions previously considered. The precentral region, bounded anteriorly by the post central region has, in the course of phylogenesis, becomes differentiated from the single sensori-motor cortex and was divided into two fields: a primary, giant pyramidal or motor zones, known as area 4 – the central motor area –, and the secondary premotor zone, known as areas 6 and 8 – the peripheral motor areas – . The general structural and functional features of the fields and the three connections with the subcortical divisions of the brain have much in common with those of the primary and secondary fields of the occipital, temporal and post, – central cortex. Nevertheless, there are important differences, due to the fact that in the cortical organization of the whole frontal lobes, in contrast to that of the posterior portion of the hemisphere, the accent in the performance of coordinated and goal – directed acts by the organism in relation to the external world in response to perceived groups of stimuli: the secondary premotor area 6 has as its principal function the performance of automation of the motor complex coordinated movement, i. e., those taking place over a period of time and requiring the joint activity of various groups of muscles.

"Area 8 may be classed as a peripheral – secondary – division of the motor zone of the cortex, although in its cytoarchitectonic structure this formation shows signs of transition to the area of the frontal cortex proper". (1)

The higher development and perfection of the whole sphere of voluntary, goal – directed acts was associated with the formation of the tertiary fields of the frontal-regions proper. These fields, occupying in man about a quarter of the entire surface of the cortex, belong to the phylogenetically youngest division of the neo-cortex. They were formed as a result of the growth, anteriorly, of elements of the same type of neural organization as lies at the basis of the motor zone of the cortex. Just as the tertiary fields of the posterior part of the hemisphere are related to the most highly generalized and integrated forms of perception of the external world, so also the tertiary fields of the prefrontal part of the hemisphere are related to the most highly integrated forms of goal – directed activity.

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(1) Ibid, P. 56.

All of the foregoing descriptions have been concerned with those cortical territories that reach their highest degree of development and their most complex structural differentiation in man that, with their connectons, occupy the entire convex supper lateral surface of the hemispheres. We have not yet considered those cortical formations situated on the medial and inferior surfaces of the hemispheres – the medio – basal portion of the cortex – and those adjoing the subcortical formation. Anatomically, one segment of the mediobasal portion of the cortex is part of the neocortex – the two marginal zones, the limbic lobe and insula, together with those sections of neocortex of the basal and parts of the medial surface of the frontal and temporal lobes that are specially related to the marginal zones functionally and topographically – areas 11, 12, 20, 31, 32 – . Also located in the mediobasal portion of the cortex are the phylogenetically older cortical formations. "The archicortex, paleocortex and intermediate cortex, the hippocampus and the adjacent formations of extorhinal cortex, and the olfactory tubercle and the adjacent semicortical structures not yet completely detached from the subcortical neurons lying within the wall of tht hemispheres–. The first of the subcortical formations to engage our attention are the amygdloid complex of nuclei, the phylogenetically older portion of the thalamic nuclei – the anterior and part of the medial groups of nuclei –, and the subcortical ganglia of the cerebral hemispheres. Most of the enumerated formations were included by the older neuroanatomists under the general heading of the rhinencephalon, and they were regarded as being mainly involved in the analysis of intergration of olfactory stimuli. The results of more recent investigations have greatly broadend the classical ideas on the functional significance of these regions, showing that these regions are involved in many different functions. Experiments on various animals have clearly shown that the regions under review are essential to the formation of behaviour and to the determination of the character of the reactions to stimulations effected through the cortex". (1) These divisions of the central nervous system are particularly important for realization of the influence of reinforcement – positive and negative – of the higher nervous activity. This is apparently the place where one can note the effects of both positive reinforcement, associated with the satisfaction of the demands of the organism and leading to a lowering of stress, and negative reinforcement influencing the organism

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(1) Ibid, P. 66—67.

to seek new methods for obtaining positive reinforcement and for relieving stress.

It is clear from what has been said that each analyser is a hierarachical cortical system constituted of three cortical zones located upon each other in the course of evolution. The tertiary zones of the analyers are the latest and superposed on the secondary which is, in turn, located above the primary zones. The main distinction between the tertiary zones on the one hand, and the secondary on the other, was previously stated. However, the essential distinction between the secondary and primary zones has not been so far very clearly ilucidated in their evolutionary context, and this is to be stressed now.

The essential distinction between the cerebral and peripheral parts of the analyers is as follows: the receptor elements of the sensory organs and the peripheral sensory neurons directly connected with them are adapted exclusively to purely mechanical discrimination between stimuli according to their physical qualities – frequency, intensity, duration, etc. – . The cerebral parts of the analyers are specilized for central processes of analysis and synthesis of stimuli, not simply according to their physical and chemical parameters but also, and mainly, according to their signal significance for the life of the organism,. Only on the basis of such indirect processing of nerve signals are the programmes or formulae of the organisms responses and actions worked out. From these topographical, anatomical relations it follows that the basic physological and biological purpose of analysers is precisely to organize the organism's whole readptive sphere. Thus, analysers are obviously a more developed tool for reflex reflection of the environment as a complex, interrelated whole through which the organism is able to adapt itself to ever more varied combinations of stimuli: "With their development there first arose in the animal kingdom a differentiated material foundation on which was built a succession of individual experience and *pari passu* the organism's potential foreseeing the probable consequences of its actions increased. The development of analysers was brought about by a qualitative complication of the reactions relating the organism to the external world; and in their progressive development it was in the influence of external medium of the organism, rather than the internal that was the essential factor ... The analysers system include those sections of neuronal organization that are differentiated last in the course of evolution and that achieve the greasted structural and functional perfection and most intensive of development. They only became clearly delineated in those vertibrates that have completed the transition from living in a homogeneous, watery medium to a more variegated terms terrestrial way of life – amphibia, reptiles–. The greatest development and complexity in their structural and functional differentiation are achieved in the higher mammals, especially in man". (1) Reptiles, finally adapted to a land existence, are capable compared with the amphibia of more differentiated perception of external influence and of using the parts of their bodies in a more differentiated way. "Correspondingly, they are the first vertibrates to display not only a great refinement of the exial mechanisms for reflex coordinations, but also a clearly expressed differentiation of the supra – axial part of the central nervous system into cortical and subcortical structures. In the higher vertibrates – mammals – the higher cortical ends of the analyers systems are represented by formations of the fully developed neocortex derived last in phylogenesis and displaying the first differentiation into layers. These parts of the brain form the morphological background on which is projected tracery of the mosaic of excitory and inhibitary points evoked by the action of various combinations of stimuli – objects – on the receptors surfaces of the sense organs". (2) The highest level of the development and perfection of the cortical ends of the analysers is achieved in the cortical formations of the primates among mammals, and of man among the primates, as repeatedly stressed.

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(1) **Poliakov, G. I., On the Neuronal Organization of the Brainl, Moscow, Mir, 1971, PP. 18, 19, 20.**

As has previously been repeatedely indicated, the higher cerebral ends of the neo-cortex of the cerebral hemispheres are of phylogenetically later differentiation and attain their fullest development and complexity and structural differentiation of cortical type in a number of mammals. With the development of analyser sytems and especially of their higher cerebral ends, the capacity of the organism to orient actively in the surroundings is qualitatively altered, broadened and deepened, thanks to the improvement in the physiological apparatus for the active tuning of the sensory organs to perceive objects. At the same time the organism acquires the possibility of acting in a more and more differentiated way on the objects stimulating it. The analysers systems are a powerful means of not only of adapting the organism to its environment but also of adapting its environment to its needs. The higher cerebral ends of the analyser systems, in their development forms – the formations of the fully developed neocortex and of the subcortex contiguous to them – have the most developed functional possibilities of elaborating newer and newer reflex coordinations that we qualify as habits, skills and knoweldge.

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(2) Ibid, P. 27.

As already noted, the activity of the analysers systems is concerned with the most complexly differentiated phenomena of complex behaviour. Its anatomical substrata are the higher ends of the analyers systems developed from the end – brain during the evolution of vertibrates. The formations of the end brain – which, in the more highly developed vertibrates, are the cerebral hemispheres and their cortical and subcortical formation – are decisive for the integration of the complete acts of behaviour, being physiologically – in Pavlo's definition – the organ of higher nervous activity. Being related to the most complex forms of analysis and synthesis of stimulation, and ensuring the fullest orientation in the external world, the higher ends of the analysers systems are a perfect instrument enabling the organism to anticipate events on the basis of past experience and to direct acts accordingly. The formations of the end brain of which we are speaking are the true organizer of all behaviour.

The understanding of the sensory process underwent a radical change as a result of the introduction of Pavlov's reflex theory of sensations. According to this theory, sensation is always an active reflex process associated with the selection of the essential – signal – components of stimuli and the inhibition of the nonessential, subsidiary components. It always incorporates effectors mecanisms leading to the turning of the peripherial receptor apparatus and responsible for carrying out the selective reactions to determine signal components of stimulus. It invisages a continuous process of increased excitibility in respect to others. In other words, sensation incorporates the process of analysis and synthesis of signals while they are still in the first stages of arrival. This means that from the beginning the sensory cortical divisions participate in the analysis and integration of complex, not elementary, signals.

The other most important part of the brain is, as already stressed, the frontal lobes of the cortex, which in man occupies up to one quarter of the total cortical mass, together with the interoparietal region constitutes the most complex and, phylogenetically, the newest structure of the brain. The prefrontal part of it is situated anteriorly to the motor – area 4 – and premotor – areas 6, 8 – and comprise a series of formations (areas: 9, 10, 11, and 46) situated on the convex portion or mediobasal surface of the frontal lobe. Anatomists now regard this region as one of the most phylogenetically recent tertiary regions; it possesses the finest structure and displays the most varied connections with all the remaining structures of the cerebral hemispheres. The prefrontal divisions of the cerebral cortex are formed only in the last stage of phylogenesis. They start of differentiating into separte fields only in the lower monkeys and attain a considerable level of development in primates; only in man, however, do the convex portions of the prefrontal region become adequately differentiated in structure, with the appearance of a series of distinct new fields not present in the immediately preceding stages of animal evolution. Comparison of the cytoarchitectonic of the cerebral cortex of rodents, the lower and the higher monkeys, and man shows at once the extent of the evolutionary development of the frontal lobes, some sections of which may with justification be regarded as specifically human divisions of the cerebral cortex. The complexity of the neuronal structure of the fields of prefrontal region is confirmed by the fact that they developed much later in ontogenesis; the fibers of these cortical divisions are the last to myelinize and that this region of the cortex begins to function later than the other regions, but it is at the same time the most vulnerable and the most prone to undergo evolution. The recent data indicate the structural complexity of the prefrontal divisions of the cerebral cortex and the diversity of their connections with other divisions of cerebral hemispheres.

The frontal lobes of the brain as a whole have a special role in the organization of the whole sphere of man's voluntary activity, from the simplest realized through motor cortex proper to the most complicated phenomena of purposeful activity effected by the frontal region and involving language and abstract thinking. This part of the brain is linked with the establishment and realization of plans of behaviour and the checking of the results of activity against intention.

Human frontal lobes, which are much highly developed than the lobes of all animals even the higher monkeys, are the main organ, especially their prefrontal parts, programn1ng, regulating and varifying conscious activity. This is due to the progressive corticalization of mental functions in man in distinction from other animals.

Phylogenetically, their tertiary formations – including the prefrontal cortex – were the latest parts of the cerebral hemispheres to be fromed, and that while they are hardly visible in the lower animals, they become appreciably larger in primates, and in man they occupy up to one – quarter of the total mass of the cerebral hemispheres, but they do not attain maturity in the child until between four and seven years of age, as previously mentioned.

In the light of what has been said, it is certain to say that the new neurological principle of the dynamic localization of the brain functions in the cerebral cortex indicates that the human brain does not contain ready-made, biologically inherited faculties or intelligence directing its mental processes. This principle also demonstrates that the material basis of the complex forms of human psychological functions – speech, memory, perception, attention, thinking – are the functional brain units, already discussed, laid down in the course of life, phylogenetically and ontogenetically, and converted into integral functional organs formed by the cerebral cortex. The mental processes are to be understood as complex functional systems, having a social historical origin and exhibiting in their structure different levels of organization. These processes take place as a result of the continued activity of the several cortical zones, each of which plays its specific role in these functional systems and supplies an essential factor for the normal working of the fundamental system as a whole.

Soviet psychologists, as we shall see also in the next part of this section, have convincingly shown that the assimilation of the social experince, leading to the development of complex forms of mental activity, cannot be regarded as a simple process of acquiring something which is already in existence, but that it is specifically human form of mental development. This development of mental processes pass through several stages, and only after its historical evolution can it lead to the formation of complex behavioural functions in which we know them from the observation of the mental activity of the human adults. This means that human psychological functions, however integrated and indivisible they seem to be, are in fact product of historical development and posses a complex psychological structure. They are the result of manifold reflex activity, formerly external in character and performed step by step, but have subsequently undergone gradral contraction and have been converted into those mental functions which we observe when we study the complex psychological processes of the adult person.

As concerns their brain mechsnisms these human psychological processes, apparently indivisible, may in fact be distributed among a wide system of divisions of the cerebral hemispheres working one with another, some of which perform the function of analysis of particular extero - and proprioceptive stimuli, others are responsible for the combined working – overlapping – of individual analysis, while a third group maintains the general tone of the cortex, and a forth group analyses information concerning performance of action and comparing and anticipating results.

B: Social Mechamisms and Mental Processes.

The study of the connections of the organism with its environment, and of the principles conditioning normal behaviour patterns, led Pavlov to the investigation of the brain. He discovered the mechanism underlying connections of the nervous system with the environmental factors: the mechanism of conditional reflexes. Over a period of many years he evolved the theory of higher nervous activity. Prior to him, the cortex of the brain, the organ of the most complicated processes of thinking, was inaccessible to phyiologists. His teaching on the activity of the higher nervous system is one of the outstanding achievements of natural science. It broadened the scientific basis of dialectical materialism, corroborated the clauses in the scientifict theory of reflection, and became a powerful factor in the struggle against idealism as a philosophical doctrine. Pavlov experimentally proved that the material basis of man's spiritual life was his brain. He also established the specific features of the activity of the higher nervous activity in man, the second signal system of human speech and abstract thinking.

When Pavlov – the initiator of modern scientific work on the brain – studied the functions of the cerebral hemispheres by the method of conditional reflexes, he proved that the primary function of these hemispheres was to analyse and synthsize the stimuli which the organism receives from the external world and to construct a circuit of new temporary connections by which the organism can adapt to the changing conditions of its environment. The higher the animal is on the evolutionary scale, the more complex the analysis and synthesis of external stimuli and the richer and more varied the network of temporary connections. Both these mentioned proesses are basic aspects of the activity of the human brain. As opposed to animals, social man is exposed to abstract and social signals of reality. These are included in language and constitute the second signalling system of reality. The existence of this system immesurably complicates the activity of human brain and creates a basis for the assimilation of the experience common to all mankind and for the development of those higher forms of mental life which are the inalienable essence of man.

One of the most important achievenments of the Soviet neuropsychology, as has been previously stated, is the introduction of the historic method into the domain of psychology and the confirmation of the well-known historical principle that the contents of human psychological processes are the product of the social form of life. And another no less important achievement of the Soviet psychology in recent years is the elaboration of brain techniques for a neuropsychological analysis of the important forms of mental activity and the application of precise psychological methods to the analysis of the role played by separate areas of the cortex in mental processes. These and a number of other original fields have emerged in the Soviet psychological science, distinguishing it from the study of psychology in the West. The scientific materialist approach to psychological phenomena impels us to regard mental processes as a historically established and highly organized activity of man. Naturally enough, therefore, this study represents an attempt to clarify the nature of the historical method which underlies all Soviet psychological investigations which provide a completely new approach to human psychological processes, which is competely at variance with that formulated by Western psychologists.

Soviet psychology holds that higher forms of reflection, which are expressed in active, voluntary and conscious forms of activity, are functions of the brain as manifested in social conditions and are not inherent properties of the mind. Soviet psychology conceives of the mind as the product of the social life and relates it as a form of activity which was earlies shared by more than one person – that is, originated in communication – and which only later, as a result of the social development of the individual, became a form of behaviour within one person. This means that the development of the distinctly human psychological functions is a process which is altogether unique. It differs from that of animals not only in the way in which biologically inherited behaviour manifests itself but also in the process whereby the individual acquires experience in life. Psychological functions which are intrinsic to man as a social being develop in an entirely unique way – through the process of social learning and mastering. During the history of man as a social creature immense progress was made in the development of human psychological abilities. By comparison, few thousands of years of the history of society produced far greater results than did the hunderds of millions of years which witnessed the biological evolution of animals. To be sure, progress in the development of human psychological functions, came about gradually, achievements being transmitted from one generation to another. But what this means is that in one way or another these achievements proved to be firm and lasting. Had the situation been otherwise these steady and continully accelarated progress that took place in human development would not have been possible. At the moment of the birth a child is merely a condidate for a human being, but he cannot become one in isolation; he has to be taught to be human being through his contact with people. Indeed, whatever distinctly human in the child's psyche takes shape during his life time. Even in the sphere of sensory functions, which one would think were so elementary, an actual reconstructuring occurs, with the result that completely new sensory abilities are produced which are exclusively characteristic of man. However, before birth and immediately after it, the individual is not "nothing" in Heideger's sense of the term, but rather an objective world reshaped by the activity of generations of people. But, the world of objects which embodies the human psychological processes that were formed during the process of social and historical development, is not prsented in its entirity to the individual in this manner from the start.

The social environment is actually humanizes the human brain. "Were I asked what I consider to be the most important results of the humanizing of the brain, I would say it is the *transformation of the cortex into an orgam which is* *capable of forming functional organs* ... I think that the concept of functional organs makes it possible to shift the problem of the biological and social aspects of human psychological processes to the plane of precise facts which can be established under laboratory conditions ... The main conclusion ... is that biologically inherited characteristics do not determine the psychological abilities of man. In effect, the individual's capacities are not lodged in his brain. The brain virtually does not incorporate within it the distinctly human abilites of one sort or another, but merely the capacity to develop these abilities. In other words, biologically inherited characteristics in man amount to only one of the conditions necessary for him to develop psychological functions, a condition, to be sure, which plays an important role. Thus, while these systems are not determined by biological characteristies they are neverthless dependent upon them. Another condition essential to the development of these functions is the world of object and phenomena, man finds himself in, a world which has been created by countless generations of people through work and struggle. This world imports to man that which is truly human". (1)

Human psychological processes, to stress again, however integral, and indivisible they seem to be, are, in the last analysis, products of the historical conditions and possess a complex inner structure both in the life of the individual and that of the whole mankind. They are, in the language of Pavlov, conditional refleexes, that is, the result of the manifested reflex activity, formerly external in character, in regard to every human being before birth, and have subsequently undergone gradual contraction and have been converted, in the brain of the individual, into mental or psychological processes. Proceeding from the reflex theory advanced by Sechenov and elaborated experimentally by Pavlov, the Soviet Psychologists regard all human mental functions as complex functional formations which are built as an outcome of concrete forms of interaction between the human organism and its social environment, especially in its cultural aspect. In other wards, human mental processes take place in concrete social conditions in the course of which each individual acquires from his social surroundings the experience of many previous generations. Thus, all forms of voluntary attention, and logical memory, conceptual perception and abstract intellectual activity are the result of the assimilation of socially formulated activity and have a similar complex structure. These types of mental processes cannot, by any stretch of imagination, be understood as direct properties of mind or as natural faculties of the brain inaccessible of further analysis: all these processes must be interpreted as products of social life passing through a complex period of historical evolution, organized at different levels and carried out by means of highly involved forms of reflex activity.

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(1) Leontiev, A.N., "On Biological and Social Aspects of human Development" in Cole, M., editor, A Handbook of Contemporary Soviet Psychology, N.Y., Basic Books, 1969, PP. 438—439, Italics not in origin.

The image of a person who was nursed by an animal but did not lose his human qualities always excited the imagination. Children nursed by animals were known in the distant past in Rome, Sweden, Lithuania, Belgium, Hungary, Germany, Holland, Ireland and France. Some 30 such cases have been recorded. All these children emitted inarticulate sounds, could not walk upright, possessed great muscular power and agility, ran very fast, jumped and climbed excellently. They have well developed hearing, vision and olfaction. Not all of them learned to speak even after a long period of time. The French philosopher Eienne Condillac described, as far back as 1754, a Lithuania boy who had lived among bears. When this boy was discovered by people he manifested no signs of intelligence, could not speak ,and walked on all fours. It took him quite some time to learn to understand human speech and to speak. In 1825 the case of Kaspar Hauser was reported in Germany. When still a child he had been alone in a cellar where he lived for many years feeding on whatever food was thrown to him. Physically he was much weaker than normally developing people and children nursed by animals, but hardly different from the latter in mental development. In 1920 Doctor Singh discovered two little girls together with a wolf in a den in India. One of the girls was about 8 and the other was 2 years old. The yaunger one soon died, while the older, who was named Kamala, lived for about 10 more years. All that time, Singh kept a detailed diary of his observations. Kamala walked on all fours, resting on her hands and knees and ran on her hands and fect. She sapped up liquid and ate meat only from floor, never taking it out of any body's hands. When approached while eating, the girl growled. At night she howled. The girl saw very keenly in the dark and was afraid of stong light, fire and water She did not let herself be washed. In the daytime she slept in the corner, facing the wall. She tore clothes off her body and threw off the blanket even when it was cold. Within 2 years Kamala learned to stand although poorly; within 6 years she learned to walk, but continued to run on all fours, as before. In the course of four years she learned only 6 words ...

In all the known authentic cases the kidnapers were wild animals, mostly wolves, and in a few cases bears and even a leapard. Press reports of children borne away and brought up by monkeys, proved false. The Tarzan story, therefore, has no biological corroboration. But why predatory animals only? For there is a biological basis: losing its young for some reason, a female that carried off a child for food (primitive women often leave their infants at the edge of the forest, when doing field work), succumbs to its maternal instinct. It gives milk to the baby then repeats the procedure and protects the "adapted" child to its own. The decisive factor, however, is that wild animals feed their young with meat after the suckling period. This instinct of predatory animals – the "foster parents" – save the life of many an abducted child.

By virtue of the adaptibility of its human brain the child learned the cries and actions conveying desired responses in animals, compelling them to feed it over the space of two, three or more years. But why did they move about on all fours? Chiefly, perhaps, because by trial and error they learned that the quadrupedal posture was the most acceptable to their predatory "breadwinner". The erect posture might have evoked the latter's defensive reflex and weakened the feeding reflex. Besides, we teach our children to walk at a certain age, their anatomy and physiology being adaptable to bipedal locomotion on condition that demonstration and instruction are employed at the right time. The nervous system of the miraculously surviving children showed an astonishing degree of adaptibility to the unusual natural environment. Possibly, children owed this to instinct inherited from acient hominidi that lived among animals and latent in normal human development. Whatever, the case, the invisible, unconscious but powerful functions of the nervous tissues of the human brain kept them alive for many years. Now take the reverse case: can the human brain degrade to animal level? No, facts show that humanisation is an irreversable process. There have been sensational reports in the press about men who lived for years in complete enforced isolation, losing the ability to speak and even the human appearance. There have been reports, too, that wearing no clothes, their bodies became covered with hair. These reports proved false. The idea that a man may become completely wild is unscientific, it is deeply hostile to science, much like a superstitious belief. Man does not lose his speech or his thought ability for lack of intercourse with other humans. That may occur only through pathologimalfunctions of the brain. Medicine rejects the idea of such effects being produced by isolation, ascerticism or any other unusual mode of life. Certainly, man does not flourish in isolation as did the fictional Robinson Crusae; he then becomes coarser inside and out, forgetting many of the refinements of life. His speech may become poorer, his mental powers be concentrated on physical self. In sum, he may lose a part of his original cultural potential, but never does he part with all of it. In this context, it is more important to underscore again the authentic facts determining the opposite. Over the centuries tyrants threw revolutionaries, malcontents, rivals and traitors into dungeons for life or long terms of strict isolation. Written sources contain not the slightest evidence of any of them being incapable of speech, of articulate sounds, or their bodies growing hairs, although, indeed, on release they were bearded, dishevelled, emaciated, sometimes blind or demented. There is written evidence to the contrary: of people preserving exalted thoughts and feelings, and their cultural charam during their long solitary incarceration. Insanity brought on by seclusion is a dislocation of mental and oral functions rather than a return to an animal state. The ability to distinguish phonemes, both heard and spoken, to link the phonetic form of a word with its inner form and sense, once acquired by an individual brain, is never lost. Thus, criminals hiding from justice, lepers isolated from society, shipwrecked voyagers, lost travellers, prisoners in dungeons do not become savages, as ingnorant people would have us believe. An individual, once he has grown in a human milieu and has been initiated in social inter-course and behaviour, carries his qualities with him as his essence. This applied also to cases where he is forced to live in complete isolotion, away from a collective or community.

During the evolution of animal organisms, there has been the emergence or establishment, complication, and perfection of both the brain mechanisms of conditional reflexes and of their quantity, forms and various manifestations. The brain, and indeed the whole central nervous system, has developed in the course of evolution of the animal kingdom as an organ providing the most perfected form of adaptation to the conditions of the evironment by menas of which Pavlov has designated as a signalling activity, that is, the animals, and man, of course, perceives a stimulus not only as a direct physical or chemical effect but also, and mainly so, as a signal or warning of the approach of a definite event important to life. As the relations with the external world become more complicated during the evolution of the animal kingdom, the brain mechanisms of the reflex – signalling – activity – as well as the conditional reflexes themselves grew extraordinarily compticated. Thus, there is a transition from the elementary sensory reflection of the quality and intensity of stimuli, in the lower animals, to reflection of images and things and phenomena – the stage of the development of the sensory signalling system in the higher animals and man who has a second signalling system: speech or language both oral and written.

The concept "second signalling system was set forth by Pavlov (1932) to define the fundamental differences in the brain function between animals and man. The animal brain reacts only to direct visual, acoustic and other stimuli or their traces, and the resulting sensations constitute the first signalling system. Man, however, possesses, in addition to the first signalling system, the ability to generalize with words the countless signals of this system. In so doing, a word becomes a signal of signals. Thus, the second signalling system is a qualitatively unique form of higher nervous activity peculiar to man: a system of speech signals: pronounceable audible and visual. The analysis and synthesis performed by the cerebral cortex when a second signalling system is present relate not only to individual, concrete stimuli but also to their generalization in the form of words.

The second signalling system developed as a result of the activity of the entire cerebral cortex. It arose in the course of evolution during social activity. The capacity for the generalized reflection of phenomena and objects provided man with an unlimited ability to orient himself in the surrounding world and enabled him to create science and art. The first and second signalling systems represent different levels of a unified higher nervous activity, but the second signalling system is more important. It came into being solely under the influence of man's dealing with other people-that is, it was determined not only by biological factors but also by social ones. The nature of interaction of the two systems must vary with the individual's educational level – the social factor .

Some people have a relatively week first signalling system; their direct sensations are dull and weak-intellectual type. Others, in contrast receive the signals of the first signalling system clearly and strongly-artistic type. However, the timely and correct development of both signalling systems are needed for the sound development of the personality.

Investigation of the role of speech in the formation of imagination and thinking constitute a major chapter in the Soviet psychology. Also of great importance are studies of the role of speech in the formation of new connections – conditional reflexes – which is one of the most difficult problems of the psychology and physiology of the human higher nervous activity – the principle of abstraction – and, at the same time, the generalization of numerous signals. The word is a signal of signals, which constitutes the foundation of the second signal system. Close interaction between the first and second signal systems is a distinctive feature of the human higher nervous activity. Temporary connections – , conditional reflexes – are formed in animals as a result of the combination of neutral stimulus with an unconditional reinforcing – stimulus: With repeated presentation of this combination the newly formed temporary connections strengthened. If reinforcement is eliminated, the connection is extinguished.

Recent investigation, especiatly that of Luria, have shown that all the laws characterizing the formation of new temporary connections in animals undergo some changes when applied to humans, for whom the formation of new temporary connections occurs in close connection with the verbal system. In animals the formation of new temporary connections occurs when a nondifferentiated stimulus is combined with unconditioned reinforcement. Human conditioning can occur without an unconditioned reinforcement. In animals the formation of new temporary connections occurs when a nondifferentiated stimulus is combined with unconditioned reinforcement. Human conditioning can occur without an unconditioned reinforcement. In animals the elaboration of a new system of connections requires many trials, as a rule, passes through a phase of elementary generalization and only subsequently to specialization. This contrasts with the human, who formulates the association in a speech system. Human conditioning can pass over these elementary phases and immediately acquire a specilized character. Preservation of a system of connections in animals requires constant reinforcement. This rule proves not to be obligatory for people. After removal of the reinforcement, the system of connections is maintained by the rule which was formulated. The system is preserved because it is supported by the correspondence of the external response to this internal rule. Transfer of the reinforced system to a system of self-regulation is one of the distinctive features of human higher activity. As was indicated above, the alteration of an elaborated system of connections is difficult for the animal and requires new prolonged training accompanied by constant reinforcement of each altered link. In the human a signal presentation of one of the members of the elaborated system with new reinforcement, opposite in its meaning, immediately produces a general verbal formation. If you say to the subject, for instance, "now it is necessary to do the opposite" the new system becomes strong in a single trial. It not even necessary to reinforce the second member of the pair of stimuli.

One of the basic tenets of the Pavlovian theory of reflexes is that there are two kinds of reflexes: unconditional and conditional. The evolutionary accumulation of species experience is fixed – unconditonal – reactions of various degrees of complexity performed at different levels of the central nervous system, beginning at the spinal cord and ending at the phylogenetically older subcortical and cortical formations of the cerebrum. Conditional responses, on the other hand, which constitute the acquired behaviour of the higher forms of life, especially at the level of man, are learned during the lifetime of every individual and that their brain mechanisms are the higher regions of the brain.

In dis-covering the reflex nature of human psychological processes Pavlov presented to psychological research two factors of different significance although close to each other in mechanisms: coupling and signalization. He showed also that brain mechanisms of conditional reflexes in man differ qualitatively and in quantity from those of animals. The origin of the difference in the sturcture of the brain lies in the process of biological evolution whereas the source of other differences is of social historical nature. The behaviour of an animal, however complex, is the outcome of two factors: unconditional – instinctive – tendencies and direct individual experiences, formed in the course of life as conditional reflexes. In contrast to this, as previously stressed, conditions inside of which human behaviour is formed include yet a third very important element, beginning to play the decisive role in the formation of human higher mental functions: the assimilation of the experience of mankind in general, which is incorporated in the objective activity, in language, in the products of work and in other forms of social life. This signifies that the transition from the animal world to the stage of man indicates the introduction of new principle of development. At the animal stage of development the behaviour of each species is, entirely and exclusively, the result of individual experience based upon the collective fund of a few instincts – unconditional reflexes, – but with the transition to the stage of man the basic form of behaviour or mental development becomes the acquisition of the experinces of other individuals through joint practice, and speech. Language, which is incorporates the experience of generations or, more broadly speaking, of mankind, is included in the development of each individual from the first months of his life.

Following the theories of Sechenov and Pavlov, modern science of psychology regards the higher mental process, as repeatedly has been stated, as complex reflex activity, responsible for reflecting the outside world. From the point of view of the Soviet psychology, the higher human mental processes are complex reflex processes, social in origin, mediate in structure, and conscious and voluntary in the mode of function. Modern materialist psychology considers that the higher forms of human mental activity are socio-historical in origin. In contrast to the animal, as mentioned already, man is born and lives in a world of objects created by the work of society and in world of people with whom he forms certain relationships. With the progress of civilization these objects become more complex and the individual becomes increasingly more involved in them. From the very beginning this milieu influences the child's mental processes. However, the child does not live entirely in the world of ready – mode objects, produced by the work of society. From the very beginning of his life he must always be in contact with other people, and, in so doing, he must objectively master the existing language system and, with its aid, profit from the experience of other societies and other generations. This contact becomes the decisive factor in his future mental development, the dicisive condition for the formation of the highest mental functions distinguishing man from animals.

The historical approach to the higher mental functions, revealing their social nature, thus, eliminates both the metaphysical – spiritualistic – and the naturalistic – non social – interpretations of these processes. The social genesis of the higher mental functions – their formation in the process of objective activity and social communication – determines the social fundamental characteristic of these functions. As examples of the mediate of higher mental functions, we may use, as Luria suggests, any performance of a particular task by means of tools or solution of an internal, psychological problem by means of an auxiliary sign in order to organize the mental processes. When a person ties a kont in his handkerchief or makes a note in order to remember something he carries out an operation apparently quite unrelated to the task in hand. In this way, however, the person master his memory; by changing the the structure of the memorizing process and giving it a mediate characer, he thereby broadens its natural capacity. Mediate memorizing illustrates the structural principles of the higher mental functions. A closer analysis shows that this mediate structure is characteristic feature of all higher mental processes.

Speech, as already stressed, plays a decisive role in the mediation of mental processes. By being given a name, an object or its properties, is distinguished from its surroundings and is related to other objects or signs. However, speech not only gives names to the objects of the outside world; it also distinguishes among their essential properties and includes them in a system of relationships to other objects. As a result of language, man can evoke an image of a particular object and use it in the absence of the original.

At the same time, speech, differentiating among the essential signs and generalizing on the objects or phenomena denoted, facilitates deeper penetration of the environment. Human mental processes are then elevated to a new level and are given new powers of organization, and man is enabled to direct his mental processes. This means that man never stands alone before the objective world surrounding him. His connections with the world are mediated by his relationships with other men, and this renders inter-course with them by language necessary. It is by virtue of the intercourse through the medium of language that man possesses the knowledge that has been stratified many centuries of practical human experience. Animals, on the other hand, are dominated by the physical presence of concrete isolated objects. The main handicap hampering the flexibility of their behaviour is the lack of language which can bring the mind what is not present. The absence of the apparatus of speech prevents the animals to recall what is absent and makes it unable to deal with abstractions. Thus, speech is the strict dividing line between animals and man. Children who begin to talk act as human beings, while those who have not, act like animals. The difference in their actions seems to be unrelated to age, but closely linked with the presence or absence of linguistic accomplishments. This means, in other words, that a word connected with direct perception of the object, isolates its essential features; to name the perceived object – a glass, – adding its functional role – for drinking, – isolates the essential and inhibits the less – essential properties of the object;, to indicate with the word "glass" any glass regardless of its shape, weight, etc.. makes its perception permanent and generalized.

Owing to the entire preceding life of the human his speech, or his language spoken or written, is intimately connected with all environmental phenomena or stimuli coming to his cerebral hemispheres, signals all of them, replaces all of them and can, therefore, evoke all the actions and reactions which these stimuli produce. Thus, among the factors capable of influencing the behaviour of human being, or his higher nervous activity in the terminology of Pavlov, words are especially powerful and play an essential part in the individial and social life of man. In addition, verbal stimuli act as an abstraction from reality and admit of generalization, thus forming the specially human, higher, thinking. Abstraction from reality, characteristic of speech, is achieved because the image of the objects and actions expressed in words and ideas replaces their concrete effect on the human being.

The fact that the combination of one verbal stimulus with another gives rise to very complicated temporary bonds superimposed on each other in keeping with man's growing life experiences, is also of great importance. However, the most important characteristic of the words does not lie in their possible use as substitute for conditoned stimuli – it is possible to establish responses to words even in animals – but in that they introduce a new principle into higher nervous functioning: the principle of abstraction and generalization. The mastery of verbal speech enables man to discriminate the the important and substantial features of objects and phenomena, and abstract these from the insignificant and non-significant – features. It enables him to develop a generalized knowledge of reality and to create historical experience which can be presented in words.

Every thing which has been said concerning the localization of functions applies in large measure to the complex question of the cerebral organization of speech processes. Speech sources are not to be found in the depths of the organism, but in the historical conditions out of which emerged the inter – personal division of labour. It arose among members of the primitive society where the objective necessity for more complex forms of communication first appeared. Under the conditions of primitive society language began to develop as a means of communication; there, in accordance with laws not yet known to us, verbal speech appeared. In the development of verbal speech words gradually became separated from work activities and from signalling gestures; words began to abstract and at the same time to generalize various characteristics of objects. In the later social history language attained its complete phonetic lexical and grammatical structure and gradually became the objective system of codes which is well known to contemporary linguistics. Without a language of the history, and structure of this system of codes no scientific analysis of the development of speech processes is possible. The formation of speech processes is related to important changes in the structure of the functional systems of the brain. With the emergence of what Pavlov considered to be the second signalling system of reality derived from the abstraction and at the same time generalization of innumerable direct signals, the most complex form of reflex activity, formerly the basis of animal behaviour, took on new specific features in man.

The processes of analysis and synthesis of external stimuli, when mediated by speech, acquired new forms. Modes of orientation to the environment and the formation of reflex connections are essentially altered; instead of gradual elaboration of new conditional reflexes which is typical in animals it becomes possible for a connection to be established rapidly by means of its inclusion into one or another thought system fromulated in speech. Finally, there emerges a new level of voluntary and conscious behaviour which, while preditermined to the same degree as the more elementary forms of reflex actity, differs in the fact that, in this case, behavioural acts are determned by complex systems of connections determined by past experience and evoked by langcage mechanisms. On the other hand, with the development of language cerebral mechanisms lose their narrow localized character and take on altogether new systematic characteristics. It is important to mention here that in invistigation of the cytological and neural structure of higher nervous activity a whole generation of scientists worked. The results of this work place us in a much more favourable position for the solution of the speech problem than was open, to earlier neurologists. While Broca and Wernicke were forced to create their own hypotheses as to the structure and general functions of variaus brain areas, we may, and must, base our investigations on a great body of knowledge regarding the general structure and general functions of various brain systems.

Natural science indicates two important factors fundamental to the development of the behaviour of animals. An animal receives part of the forms of its behaviour ready-made, from previous generations; it inherits these forms from its ancestors. These inherited forms constitute one section of the animal's behaviour and occupy a greater place the lower we descend down the evolution scale. The second section of the behaviour is comprised of these aspects which each individual acquires during its life. The higher the position an animal occupies on the evolution-ary scale, the greater the role played by the forms of behaviour acquired in its individual experience. The behaviour of man, on the other hand, includes, as previously stressed, both these forms, but man possesses yet another means of acquiring new experiences which animals do not. No animal can acquire new knowledge or abilities except by a direct interaction with its environment. There are no animals which can ask their elders how to perform a certain action. There none to which the experience of previous generations can be transmitted by any means other than by direct hereditary or direct immitation. It is quite different with man. Man masters verbal speech and with its help he can assimilate experience accumulated over thousands of years of human history. The development of mental functions by means of acquisition through language of experience common to mankind is the third type of development. For animals there is only biological evolution, but for man, history is more important and man's accumulated forms of behaviour must be examined as a product of his social history and not merely as a biological product.

The higher mental functions of man, therefore, as repeatedly stressed, are functional systems, social in origin and mediated in structure. This primarily "means that complex forms of behaviour can not take place without the direct or indirect participation of speech and that the connections of the second signal system play a decisive role in the formation of these activities. However, by adapting this point of view the usual notion of speech as one of the special forms of mental activity must be modified slightly and, besides speech processes being understood by the narow meaning of the term, the general speech organization of mental processes must be distinguished. Because of speech, abstraction and generalization of direct stimuli received from the outside world is made possible; speech can thus compass relationships and associations between objects and events extending far beyond the limits of direct sensory perception. Because of speech, our perception acquires a selective systematic character. Finally, because of speech, higher nervous activity in man acquired that property that which enabled Pavlov to describe the second signal system as the higher regulator of human behaviour. Speech activity, in this wider sense of the term, extends far beyond the bounds of processes that may be oberved during verbral communication between prople. Naturally, therefore, the speech organization of mental processes must be considered the activity of the brain as a whole, i.e., based on the combined work of the whole complex analysers. Because of its exceptional complexity, the speech organization of the higher cortical functions is very easily deranged by any local or general brain lesion. And it is very important to mention here that ever since the classical investigations of Broca and Wernicke at the end of the last century it has been known that, despite their morphological symmetry, the two cerebral hemispheres are not equal in functional importance. In right - handed persons the left hemisphere is predomenantly concerned with speech functions and is dominant in this respect; whereas the right hemisphere does not carry such important - primary - speech functions and may therefore be designated as subordinate. For this reason, most investigations have been concerned with the study of the disturbances of higher cortical functions arising from the lesions of the left-dominant-hemisphere, whereas the symptonatology of lesions of the right - subordinate - hemisphere has, until very recently, not received adequate attention. Novertheless, the dominance of one hemisphere in relation to speech function proved not to be so absolute as was supposed, and research showed that the degree of dominance varied considerablly from subject to subject and from function to function. Accordingly, the higher mental functions, including speech, of sourse, result from the combined activity of both cerebral hemispheres, with each making its own, though not equal, contribution. The part played by the two hemispheres in the organization of higher mental functions is a matter for further research. However, although the role of the subordinate - right - hemisphere in the higher cortical functions cannot yet be defined, the clinical observations of many writers have convincigly shown that in the left - handed persons lesions of the subordinate - left - hemisphere also leads to definite disturbances of speech and its related perceptual processes. Correspondingly, with lesions of the dominant hemisphere, speech - as well as related functions -

is disturbed to a different degree in different subjects and may redevelop unequally being restorted comparatively satisfactorily in some and hardly at all in others. Therefore, as already stated, the degree of dominance of the hemispheres varies not only from subject to subject, but also from function to function, and the conception that the two hemispheres, although morphologically identical in structure, are not identical in their degree of functional differentiation, not only in regard to speech but also to sensory – and possibly motor – functions, has only recently found expresion in literature.⁽¹⁾ However, it is easy to see that our lack of knowledge concerning the degree of dominance of the hemispheres in different persons and with regard to different functions is a great handicap in the clinical investigations of patients with local brain lesions.

As already stressed repeatedly, the mental development of the child is qualitatively different from the ontogenetic development of animal behaviour. This difference is primarily determined by the fact that what is most important to the child's development, and absent in the animal world, is the process of mastery or appropriation of the experience which has been accumulated by mankind in the course of social history. In the case of animals we meet only with experience of two kinds: experience formed in phylogensis, reinforced by heredity, and individual experience acquired in the course of life. To these there correspond behaviour mechanisms of two kinds: on the one hand, there are the mechanisms of

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(1) Zangwill, O.L., Cerebral Dominance and Its Relation to Pschological Function. London, Oliver, 1965.

heredity which either come fully into action at birth or gradually mature in the process of ontogrentic development – the formation of these mechanisms procedes according to the general laws of biological evolution and is a slow process answering to slow changes in the environment. In animals these mechanisms have a fundamental adaptive significance. On the other hand, there are the mechanisms of acquiring individual experience: conditional reflexes. The most important characteristic of these is that, through heredity, they embody only the potentiality of forming that behaviour which is realized in individual adaptation – the behaviour itself is fixed through the mechanisms of acquiring individual experience allow animals to adapt themselves to rapidly changing conditions in the environment, the actual evolution of these mechanisms as also of the mechanisms of hereditory behaviour, proceeds slowly.

It may be taken as scientifically established fact from the moment of the appearance of the human being of the present type – *home sapiens* –, the process of independent morphogenesis ceased. This means that the further development of man does not proceed as a result of morphological consolidation, the operation of natural selection and of hereditary transmission, slowly accumulated as a result of the changes in his nature over the generations. That is, the laws of biological development cease now to relate to the historical development of mankind and of man. The process of social development, from that period, is directed by new laws, the sociohistorical laws, which apply both to the development of society and to the development of individuals comprising it. This means that the process of man's historical development is not determined by the action of biological inheritance, but is achieved solely in human society; by particular form of transmission of achievenments in the succession of generations folowing upon generations. The point is that these achievements are fixed, not by morphological changes, transmitted thenceforth by heredity but in the objective productions of human activity – material and cultural – in the form of human creation, as in tools, in material industries, in language – in systems of logic, in science– and in artistic creation. For, in all these human products; from the first hand implements made by man, to modern technology, from the primitive word to contemporary highly developed languages – lies the collected work of real people, their material and cultural activity, which acquires objective form in their products.

On the other hand, each individual encounters a world which is formed and created by the activity of the preceeding generations: a world which enbodies within itself the attainment of the scio – historical development of human mental abilities. However, a human being does not simply stand, before this world, he must live and act in it: he must use tools and instruments, employ language and logic, working out a social practice. Ultimately he does not remain indifferent to artistic creations, and enters into aesthetic relations with them. Human mental processes, with reference to the complex of socio – historical forms of activity, that is the specifically human mental functions, are really newgrowths, biult up during his individual development, and they are not expressions or variations of those which are implanted by heredity. The development of these processes in the case of the individual proceeds in the process of their involvement or appropriation of that which costitutes humanity in its historical development, which constitutes society. However, the process of appropriation – assimilation – must not be comfused with the process of acquiring individual experience. The process of acquiring individual experience is, as is well known, the result of adaptation of the individual to the variable conditions of his surroundings on the basis of the inherited experience, transmitted through the species. In contradistinction to this, the process of appropriation which is entirely absent in animals, is the process of acquiring by man not only of the phylogenetic experience of animal ancestors, but of human species experience that is, of socio-historical experience of preceding generations of people. This experience does not lie in the inherited organization of man, not within, but without – in the external objective wold, in human objects and phenomena about the man. This world – the world of tools, sciences and arts – really contains in itself the nature of humanity, the totality of its socio – historical forms, for a man it also contains mankind. The mastery of this external world, its acquisition by the individual is the process as a result of which the higher mental functions embodied in the external forms become the internal property of his personality, the inherited elements of his individuality. These organs are formed during his activity, his use of human tools and objects and through cooperation with other human beings who show him the use of tools and help him to employ them adequately.

It should be particularly understood the two different forms of the animal experience and the corresponding two mechanisms of behaviour, are interconnected both genetically and functionally. It may be considered as an established fact that manifestations of hereditary behaviour do not appear independently of individual experience; on the other hand, individual behaviour is always formed on the basis of the hereditary behaviour of the species. The individual behaviour of animals, therefore, always depends on the experience of the species, the instinctive behaviour fixed in the mechanisms of unconditional reflex activity, and an individual experience which takes place in the ontogenesis by means of the mechanisms of conditional reflexes. The basic function which the mechanisms of forming individual experience perform for animal is the adaptation of species behaviour to changeable elements in the environment. The ontogenetic development of animals can be represented as the accumulation of the individual experience, perfecting of the operations which realize their instinctive activity in complex and dynamic external conditions.

The case of man is entirely different. By contrast with animals man has experience of yet another kind. This is the social-historical experience that he masters. It does not coincide either with the species experience, inherited biologicallys or with the individual experience though often incorrectly confused with this. What is then this experience that is exclusive to man alone? In the course of history, men, governed by the action of social laws, have developed higher characteristics of mind. Thousands of years of social history have produced more, in this connection, than millions of years of biological evolution. The achievements of mental development have been accumulated gradually, transmitted from generation to generation. This is the way they have been consolidated. Could they have been consolidated in the form of biological, hereditary transmitted, changes? No. Because the historical progress is tremendously rapid, always accelerating, and consequently the demands upon man's abilities made by the conditions of his life in society, change rapidly quite out of relation to the much slower process of biological fixation of experience. The achievements of historical development are consolidated and transmitted from generation to generation in a partienlar form namely, in an exoteric, external form. This new form of accmulating phylogenetic — or, more precisely, social — historical — experience has arisen because man specific form of activity is productive activity. Every object created by man (from the simplest tool up to the contemporary electronic computor) embodied the historical experience of mankind and together with this the intellectual abilities formed in this experience. The same may be seen still more clearly in language, in science, in the work of art. Thus, by contrast with the phylogenetic development of animals, whose achievements are consolidated in the form of changes in their biological organization, in the development of their brain, the achievements of man's historical development are consolidated in the material objects, in the social phenomena, language, science — created by man himself. What is more complex and much more important for man is the other process, the process of mastery or appropriation by different individuals of the achievements of the cultural development of the preceding human generations embodied in the actual objects and phenomena they have created. Hence, the child from birth is surrounded by an objective social world created by society, and that he begins his mental development in a humanized world. Does not the child's development taks place as a process of adaptation to the world? No, despite this widely held view, the concept of adaptation does not reflect the essentials of his mental development. A child is not adapted to the world of human objects and phenomena surrounding him, but takes it to himself, i.e., appropriates it. Biological adaptation is a process of changing the qualities of a species, both the qualities of the object and its natural behaviour, which is evoked by the requirements of the environment. It is otherwise with process of appropriation. This is a process which has as its result reproduction in the individual of the historical formation of human qualities, abilities and characteristics of behaviour. Let us consider, for example, how a small child in a modern society masters a simple instrument such as a spoon. We may begin with an imaginary case. A child has never seen a spoon and one is now put in his hand. What does he do with it? He may manipulate it – move it from one place to another, make a noise with it, try to carry is to his mouth, etc. In other words, it is not the developed social skill of using it, which is embodied in its peculiarities of form, that is manifested to him but its unspecific natural or physical properties. We may turn now to an actual case. The mother feeds the child with a spoon; after a little time she puts the spoon in his hand and he makes an attempt to eat independently. As observation has shown, at first his movements are subordinated to the instinctive tendency: to carry what is held in his hand to his mouth. The spoon in his hand does not keep the necessary horizonal position and as a result the food fails outside his mouth. But, the mother does not remain indifferent, she helps the child, taking part in his actions. Therefore, there arise combined actions with the child and the habit is gradually formed of using the spoon correctly. A child now masters the spoon as a human object. This is, of course, an example relating to the formation of motor operations. But how much more obvious is all that has been said in the analysis of the mastery of mental actions as reading, writingfi counting !!. It is particularly clear that the formation of such mental actions is itself a process of mastering operations formed in the experience of preceding generations. The most important processes which characterize the mental development of the child are the specific processes whereby he masters the achievements of the development of the previous generations of men, which, by contrast with the achievements of phylogenetic development in animals, are not fixed morphologically and are not handed on by the way of heredity. However, such activity cannot developed by a child himself. It develops in practical and verbal intercourse with people surrounding him in combined activity with them.

That is the psychological, which is, of course, social in origin, side of the genesis of human mental functions. We now consider their physiological side in the light of the contributions of the famous Soviet psychologists: Leontiev,(1) who was recently awarded the Lenin prize for his creative contributions: they are formed in the "process of formation of functional cerebral organs or systems,,. "The proposition that mental abilities and functions formed in the process of social – historical development are produced in the individual men not by the action of biological inheritance but by acquisition in the course of life, poses a very complex question of the anatomical – physiological basis of these abilities and functions. From the scientific materialist point of view it is impossible, of course, to postulate the existence of abilities and functions which do not have their specialized organs. How can we reconcile the view that the higher mental functions of man have their own morpho-physiological basis with the assertion that those functions are not of fixed morphological but are transmitted by way of social inheritence? One approach to the solution of this problem was the successful development of the physiology of higher nervous activity. I have in mind primarily the classic work of Sechenov and Pavlov,(1) and their colleagues. From another angle light has been thrown upon the problem by many psychological investigations into the formation and structure of complex mental functions in human beings, which I would mention Vygotsky, and his colleagues. The suggested solution of the problem is that simulteneously with the formation in the child of higher specifically human, mental processes, there are also formed the cerebral organs essential to their functioning – that is, stable reflex formations or systems used to perform special acts... The results of the researches we have undertaken permit a more detailed characterisation of the functional organs that arise in the course of life ... The first of their characteristics is that, once formed, they function as a single organ... Another characteristic is their durability . The functional systems in question are formed by way of the formation of conditioned connections but are not extinguished... The third characteristic is that those systems can persist for so long that their separate components can be replaced by others, so stablizing the given functional system as a whole. In other words, they display the highest capacity for compensation. In order to indicate the structure of these functional organs it is necessary first to describe their formation. They are formed by the common mechanism of forming conditioned connections, but not in the same way as the usual chains of conditioned relfexes, or dynamic stereotypes, are formed. These connections are not formed simply by external stimulation but also by the unification in a single system of relatively independent reflex acts with their different motor efferent and afferent reversals; so that unification also takes place by way of unification of their motor effectors".(1)

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(1) **Leontiev, A.N., "Principles of Mental Development and the Problem of Intellectuall Backwardness," in Simon, Brian and Joan, editors, Educational Psychology in the USSR, London, Routledge and Kegan Paul, 1963, P., 75.**

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(1) (a) Sechenov, 9, Selected Physiological and Psychological Works, Moscow, Foreign Languages Pub. House, no date.

(b) Pavlov, I.P., Selected Works, Moscow, Foreign Languages Publishing House, 1955.

In the light of what has been said it is clear now that the child is not born with organs ready - made to accomplish connections which represent the product of historical development of man; these are formed in the child in the course of life : they are of the order of appropriation by him of the historical experience. The organs of these functions are themselves functional cerebral systems or mobile physiological organs of the brain formed in the actual process of appropriation referred to above. The results of recent research show that the formation of these systems does not proceed similarly in all children; depending on how the process of development takes place, and in what conditions. They can sometimes be inadequately formed or even not formed at all.

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(1) Leontiev, Op. Cit., PP. 75—77.

And the mastery of speech is the most important condition for their formation in the child.

The behaviour of animals, to stress again, depends on experience of two kinds. There is first, the experience consolidated by heredity in the unconditioned reflexes. In its content this is the experience of the species. Secondly, there is individual experience, acquired ontogenetically, as a result of the formation of conditional reflexes. It is different in the case of man. There is, of course, in man also the hereditary consolidated species experience. Another problems is that this experience occupies quite a different place in the behaviour of man and plays quite a different role from that it plays in the behaviour of animals. Further, the behaviour of man, like that of animals, depends on the experience which is acquired by the individual in the course of life. This, however, is not merely individual experience, like that of animals. There is still another kind of experience which does not exist in the case of animals: it is the experience of the species – or, more exactly, the socio – historical experience of mankind which is assimilated in the forms of the experience of the individual. Thus, man acquires species experience of mankind, not only by way of inheritance but in the form of individual assimilation. This experience creates the specifically human form of behaviour. "Such are for example." says, Leontiey,(1) "operation with tools, speech activities ... It is only in the case of man that learning is converted into special process whereby historically accumulated experience is transmitted from one individual to another. Even in the simplest case of the learning to act as when the process takes place through the active interaction of adults in the action which the child is performing. The adult actually puts a glass in the child's hand or correct the position of the glass in his hand, helps the child to hold the glass vertically, and so on. The action is divided, as it were, between the adult and the child: the teacher and the learner."

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(1) Leontiev, A.M., Learning as a Problem in Psychology" in O'oCnnor, N., editor, Recent Soviet Psychology, London, Pergamon Press, 1961, PP. 236—240.

Higher mental functions are formed in the process of ontogenesis, passing through several successive stages. During the early stages the higher mental functions depend on the use of external evocative signs and that their pattern is one of a series of unfolding operations. Only when this is complete do they gradually consolidated, so that the whole process is converted into a concise action, based initially on external and then on internal speech. It may be concluded that at suscessive stages of their development the structures of the higher mental functions do not remain constant but that they perform the same task by means of different, regularly interchanging systems of connections. In the early stages, relatively simple sensory processes, which are the foundation for the higher mental functions, play a decisive role. During subsequent stages, when these systems are being formed, this leading role passes to more complex systems of connections that develop on the basis of speech, and these systems begin to determine the whole structure of the higher mental processes. For this reason, disturbance of the relativity elementary processes of sensory analysis and integration necessary for the further development of speech which are decisively important in early childhood, will cause underdevelopment of all the functional formations for which it serves as a foundation. Conversely, the disturbance of these forms of direct sensory analysis and integration in the adult, in whom the higher functional systems have been formed, may have a more limited effect, compensated for by other differentiated systems of connections. This implies that the character of the cortical intercentral relationships does not remain the same at different stages of the development of a function and that the effect of a *lesion* of a particular part of the brain will differ at different stages of the functional development.

C: Educational Implications

As has been previously stated Soviet psychologists do not speak about "creativity" or "giftedness" as a separate, indipendent psychological entity nor do they reveal its brain mechanisms. They speak, as was detailed in the previous section of this chapter, in broad terms about human higher cortical functions, and they employ the term "talented" to designate those individuals who have special inclination towards art or science. They assume tacitly that all nomal children are potentially talented and to actualize their potentialities, it is necessary to provide them with appropriate cultural meduim and utilizes it. Talent is nourished inside the school as well as outside it, and mainly so, through extra - curricular activity. Soviet psychologists speak also about the processes going on in the brain of man which distinguish it from the brains of the rest of the animal kingdom. They also elucidate the specific characteristics of the human brain common to all normal human beings and treat all psychological processes as forms of complex conditional reflexes.

Luria, in particular, whose ideas were summarized in the previous sections of this study, speaks about the process of thinking⁽¹⁾ but the general tone of his treatment of this process seems to suggest that creativity is the highest stage of thinking and that it is common in all normal human beings provided with similar social conditions. "The main task of Soviet psychologists in the field of psychology of abilities is to *identify conditions which would contribute to the all round development of abilities of all children...* This also includes the task of identifying those children of the school-age group who show special abilities at different kinds of activities – mathematics, technology, desining, literature, ect. and give them all the opportunities for further development of their abilities... The laboratory of the Abilities of the Research Institute of the Academy of Pedagogical Science in Moscow has been studying mathematical, techological and literary abilities of the school children for a number of years". ⁽²⁾

During classes the Soviet children are taught to work both independently and as groups. In higher grades there are lessons delivered as lectures, there is independent laboratory work and seminars at which a pupil makes a report and the class then discusses it. The teacher constantly strives to nuture in his pupil a desire to learn and a deep interest in science. Much stress is placed on the development of each child's active and intelligent mastery of knowledge. The Soviet school of pedagogics aims at developing each child's mental capacities, his ability to think logically, to concentrate and to be creative. The most important

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(1) **Luria, A.R., The Working Brain, London, Penguin, 1973, PP. 323—340.**

(2) **Krutetzky, V.A. in Proceedings of the 17th International Congress of Psychology, North — Holland Pub. Co., Amesterdam, 1964, PP. 314—351. italics mine.**

principle of Soviet pedagogics is the development of the pupil's creative thinking and intellectual initiative. The individual approach to each child is adhered to both during group and in individual study. The rapid learners are given more difficult tasks, with the slower children receiving a simplified assignments. These children who fall behind attend special additional classes which help them to catch up with their classmates as quickly as possible. These additional classes are conducted on individual basis.

Pupils of all grades are systematically drown into various kinds of socially useful work which is both within the range of their abilities and interesting in its form and content. As a rule, each teacher at the school organizes a group in connexion with his own subject for the pupils who show special interest in any particular branch of knowledge. The purpose of these subject groups is to deepen the knowledge of the pupils and to widen their educational herizon in the field of a branch of science the fundamentals of which are taught at school, as well as to encourage pupils to engage in practical, socially useful activities. Among the groups most widely found in Soviet schools, those of particular importance for the systematic widening of scientific horizons of school children are the groups or circles of young Mathematicians, young Physicists, young Chemists, young Biologasts or Naturalists, young Technicians, etc. The content of the work of these groups and the subjects for technical and experimental activities are determined, by the pupils under the teacher's direction. The entire work of the groups is build on the basis of stimulating and systematically developing the pupil's independent activity, resourcefulness, initiative and spirit of inquiry. Specialists, engineers, technicians, leading workers in production, tractor-repair-stations workers, agronomists and skilled agriculture workers are invited by pupils to give talks. These specialists unfailigly respond to the needs of schools and are always ready to assist the children with their knowledge and experience. Other forms of independent educational work are also widely used in the activities of subject groups: the reading of books, the gathering and the study of sources materials and arranging them into collections. The older the school children are, the more widely and fully all these forms of independent work are provided.

Children scientific circles are organized on every conceivable subject and activity and children are free to join any one of them. Circle activities are not confined to pioneer Palaces and Houses. as shall see, and general schools, universities and institutions of higher learning also organize the students liesure in clubs of all descriptions. Subject circles in these institutions may enter competitions and present reports, which may be sent on to city-wide and republic-wide competitions. The best of the reports are published by the Universites or Institutes. However, circle activities are not merely a leisure time entertainment for school pupils and students. They also, and mainly, serve a serious scientific and technological purpose in the scheme of education and character formation in the Soviet Union.

The circles mentional above made very respectable contributions to science and to the quality of pupil's research because of the scope of their interests, their high level of instruction and the guidance given to them. It is in this way that they stimulate outstanding talent. The orientation given to scientific activity is of the highest caliber. Scientists and university scholars work with these circles and technical stations give direction to their projects. Morever, certain circles, clube, societies, in science and engineering with high ability accept children in their membership and are directly affiliated with similar departments of the University of Moscow. In the academic year 1957–1958, for instrance, Moscow University organized a mathematics Olimpic

This Olympic was attended by the pupils of the higher classes of elementary schools. The questions and problems were those concerned with mathematics in the secondary schools programme. If the pupil does well he is identified as talented. Children from each unit also compete by solving difficult problem in mathematics. Motivation is strong since clever children are formally honored with medals, announcements over the radio and television, praise in the newspapers and exhibition of their work.

A review of the Soviet educational system would be incomplete without ilucidation of the vast network of state and community extra curricular establishments for children, young people and adults. These establishments complete the educational work being carried out by schools. They help to organize the children's free time in the most beneficial way. Extracurricular activities are also held in schools during the second half of the day. But since the review of the Soviet school system is outside the scope of this study and since our concern is essentially with the cultivation of creativity in school children, we shall concentrate our attention on those aspects of the school system relating direcatly to the creative process, especially the establishments dealing with extra-curricular activities. However, the educational system of the Soviet Union has been competent enough to elevate the Soviet mind, within the shortest period of human history, from illiteracy to the Conquest of the outer space. We have more to say about Soviet education in the next chapter of this study.

The concept of extra - curricular activity has to be reconsidered. Hitherto, extra - curricular activity meant any volentary work by the pupils carried on outside classroom and mainly not related to school subjects. Now, however, much serious work is done outside the classroom such as socially productive work, training in production. As pupils take a wider part in productive work, the system of extra-curricular activity is inceeasingly playing an important role in the educative work of the school and is bound to have its effect on the system of the lessons in the classroom itself. This effect will be that extra - curricular activity will lead to more and more educative subject - matters taken from actual life and production being added to the work in the classroom.

Side by side in close contact with the school, various out-of-school institutions in the Soviet Union carry out different kinds of educational and training work with children. These institutions help the school in consolidating and deepening the children's knowledge, broadening their scientific horizons, developing their creative abilities and interests and carrying out their training. They satisfy the children's interests in the fields of natural sciences, mathematics, technology, literature, and help to develop their abilities. Children's out-of-school institutions such as Young Pioneer's Palaces and Houses, Children's sectors in workers, and collective forms

Clubs and Houses of Culture, Children's Parks, Children's Towns in Parks of Culture and Rest and Pinneer summer camps – all carry out educational and training work satisfying the children's many interests and requirements, on the one hand, and render constructive outcomes to society, on the other.

Extracurricular institutions in the Soviet Union are state and public institutions working closely with the schools and pioneer and komsomol organizations. They are divided into two types: general and specialized. General extracurricular institutions work with children and adolescents in different fields of science, technology, sports and culture. They include Pioneers and pupils palaces and houses, children's sectors of trade union palaces of culture and clubs. Among the specialized extracurricular institutions are young technician's stations. naturalist's stations. Extracurricular institutions are under the jurisdiction of the ministries of education, culture, transportation, river transport, and merchant marine, as well as of the trade unions. They function all the year and their work may involve socially useful activity. The first extracurricular institutions were organized in 1918.

Other institutions, such as Children's Liberaries and Reading-Rooms, Children's Houses of Artistic Education, Children's Theatres and Cinemas, are also widely known. Young Naturalists and Young Technicians' Clubs (Centres or Circles), Children's Stadiums and Children's Sports Schools, Children Excursion and Touring Centres and Children's Railways and River Ports also carry out specialized work with children, organizing their activities and satisfying their social interests primerily within a single chosen field. Of considerable importance in the system of out-of-school work with children is the Central Station for Young Technicians founded in Moscow in 1926 which carries out large – scale experimental work with children and adolescents, on the basis of which the programmes for various technical groups are down – up. Local Young Technicians' Stations and Tenical Groups in Pioneers' Houses are guided by these programmes. The Central Station for Young for Young Technicians is a methodological introductional centre for technical information among children. Its consultation department receives and sends out hundreds of letters a day, replying to questions from Young Technicians and from the workers in the out-of-school institutions. The Central Stations and the local Young Technicians' Stations give practical assistance to schools in carrying out scientific education by acquainting school children with the fundamentals of modern production in their own groups and in the groups of Pioneers' Houses and by organizing mass work in the form of lectures and discussisions. They publish methodological literature to assist group leaders in schools. Those centres have technical libraries of their own and they hold exhibitions of the work of Young Technicians and organize the work of groups in workshops and laboratories. They give methodoligical and practical assistance to teachers and pioneers leaders in organizing out-of-class and out-of-school groups and mass work. They arrange seminars, consultations, practical studies and conferences, and summarize and disseminate the best experiences of technological work in Pioneer Brigades, Detachments and school Groups. They also organize, on a wide scale, the dessemination among school children of information concerning the achievements of the world and Soviet science and technology. To enable school children to compare their experience of work at collective and state farms and training and experimental plants, the Central Station organizes annual All-Union or Republican rallies for Young Naturalists. These are held at the All-Union Exhibition of the Achievements of National Economy in Moscow, with the participation of scientists, teachers and leaders in agriculture and production. The central Station conducts seminars both personal and by correspondence, for teachers, Pioneer leaders and workers at Pioneer camps.

Creative work in the sphere of technology and science is an important factor in preparing school pupils for taking part in the progress of science and technology. School children's participation in scientific and tehnological research is an important and effective means of stimulating their interests and abilities in these fields of human social activity. Much attention is paid to extra-curricular-activities and readings. The Soviet Union has at the present time more than 3,900 Young Pinoeer Palaces and Houses, over 600 Young technician's centres and about 340 Young Naturalists' centres. It is important to note here that the Soviet interest in the progress of science is as old as the Soviet system itself. At the end of 1919 the Council of People's Commissars adopted the decision : "On the Improvement of Conditions of Sceintists." During the years of economic difficulties and the civil war the government alloted special funds for creating normal working conditions for sceintists. In -921, Lenin signed the decree: concerning the improving of the research work of Pavlov and His Associates.

The extensive fostering of initiative resource, fulness and independent activity of children by means of out-of-school and out-of-class work assists the harmonious all-round development of all children and helps to consolidate and strengthen their interests in all branches of science and technology they have chosen in their favourite forms of work. Children's talents and abilities develop in step with the growth of their general culture and the broadening of their scientific horizon. The extra-curricular children's establishments are one of the greatest achievements of the Soviet school system.(1) They help systematizing the children's many needs and interests, to uncover and develop their creativity and help in their overall growth and suppliment all the school has given them. At present there are thousands of extra-curricular children's centres in the Soviet Union. Most famous among them, to stress once more, are Young Pioneer Palaces and Houses, Young Technicians and Young Nature Lovers Clubs, Excursion and Hiking Clubs, Children Sport Schools, Children's Railways and Children's Marine Clubs.

The Young Pioneer Palaces and Houses are complex educational establishments. They provide for all types of activity and are located in buildings especially equipped for all various activities. The Young Technicians Clubs unite

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(1) For detailed information, see:

1: Kuzin, N.P. and Other, Education in the USSR, Moscow, Progress, 1972.

2: Bronfenbrenner, U., Two Worlds of Children London, Penguin, 1974.

children interested in radio engineering, electrical engineering, airplane designing, shipbuilding, automobile designing etc. The Young Nature Lovers' Clubs are divided into sections of: gardening, agrochemistry, horticulture, animal care, tea breeding, and ichthylogy. These Clubs have their own plots, hothouses, botanical gardens and animals farms. The Young Hikers' Clubs organize hikes and trips for school children who want to know more about their native land. Children's Railways and Children's Marine Clubs teach the children the fundamentals of railways, and marine transportation.

There are, in addition, for grown-up children, students' scientific and technical societies, which are open to all who have been admitted to the institutions of higher learning even those in their first year. These societies encourage anyone tends to enter into the world of dis-covery and invention. It is of interest to point out here that the general educational tendency in the school system of the Soviet Union is that students can and must learn from the first to create, himself working to dis-cover precious grains of the human knowledge in any of its various manifestations. The student is not just a vessel to be filled with school information; he is a torch to be lit. This is a general trend in all Soviet schools. Scientific and Technical Societies are like great incubators of creativity. They are assisted by the All-Union Society of Inventors and Efficiency Promoters. Colleges and institutions of higher. learning also provide their students scientific societies like all other students free of charge-with all necessary laboratories apparatuses and facilities, and students can get all the scientific advice they need from the teaching staff.

Extra facilities required are readily granted to any college by research institutes. One of the outcomes of this educational procedure is that in the academic year 1971–1972, for instnace, students produced more than 2,000 inventions-both independently and in collaboration with experienced scientists. Encouragement of student research is a fundamental task of Soviet institutions of higher learning. For some time Soviet colleges have been holding an annual Science Week: a kind of creative review of the work of a huge youth team. During the first few days of this Week students are given by major experts detailed lectures on problems confronting modern science and technology. This is followed by round-table conferences in the debating Clubs. This Week is timed to coincide with the college annual students' Scientific Societies conferences.

During and after shool hours there are community centres, trade-union, clubs, and verrious other establishments under the Ministry of Culture(1) – theatre, opera, ballet, music, circus, museums and art galleries, cinemas, radio, television, liberaries and sport organizations-carry and encourage all sorts of creative for and with school children. These and similar extra-curricular children's establishments are one of the greatest achievements of the Soviet society. They help to satisfy the children's many psychological needs and interests and uncover and develop their creativity. They help also in their overall intellectual growth and suppliment all the school has given them. There are, in addition, and very important other scientific institutions created especially for young students. One of them is the Junior or Minor Academy of Sciences established in the Crimea in 1966 with aid of the Academy of Sciences of the USSR. There is also the School of Inventors which was founded in Baku in 1971. Its theoretical assumption is that invention is somthing that can be taught. This quite unusual school accepts about a hundred students at a time for a six-month course. In addition, the Department of Experimental Physics of Kishineo University has a special Physics group for older school children where they have a chance to perform scientific experiments in actual laboratory conditions and solve complex problems. The staff of the Department of Mathematics guides the Young Mathematicians Clubs. For many years now there has been a Young chemists group affiliated with the Department of Chemistry. This provides a great creative stimulant for further knowledge and higher level of creativity.

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(1) USSR Cultural Life, Moscow, Novosti, 1974.

Compatitions of school children in such subjects as mathematics, physics and chemistry have been very popular and, in the past few years, have been conducted on a national - wide scale. There are usually three rounds to these competitions. The first is done by correspondence, with problems of physics or chemistry at the level of the 6th - 8th grades appearing in the children's and young people's newspapers and magazines. They call for commonsense, the ability to think logically and to solve non-standard type of problems. Any creative approach that indicates originality takes the contestant into the second rounds which are held in the spring in Regional and Territorial centres. The third and final round is a contest which matches the winners of the second round. It has become the custom for the winners and the participants in the last round to meet with outstanding scientists in the field and use the laboratories of scientific institutions. During the last few years there have also been contests in biology, geography and philology. These contests help to dis-cover the creative process in children, and grown up students. There is also a wide spread campaign entitled: Young Technicians Help Their Schools. "Children built working models, wire and equipments for various laboratories. The best work by the young technologists is on the display at the USSR Economic Achievements Exhibition where they have their own Pavilion. Young Nature lovers have their special Days, for instance, a Bird Day, a Forest Day, etc. There are also many Flower shows. Millions of school children take part in exterminating harmful insects in the woods and fields, in building bird houses and bird - feeding stations. The Ukranian Republic Young Nature Lovers Camp hsa, in the 35 years of its existence, a laboratory of nature study. During the summer vacation the winners of the various nature prizes, biological centres and Republican-wide competitions in nature study, gather there, children exchange experience, meet with scientists and eminant agronomists. The central Young Nature Lovers and Experimental Club was founded in Moscow since 1934.

Competitions, technical contests, exhibitions and organized meetings with scientists, inventors and skilled workers are frequently held among school - children in their out-of-class and out-of-school work in physics, chemistry, mathematics and biology. This broadens and deepens their knowledge in various fields of technology and theoretical science. School children also acquire and consolidate practical knowledge and skills and develop their creativity. Out-of-class and out-of-school work gives children an opportunity to test their creativity in a practical way and makes it clear for them to choose a career and subsequently to master the speciality they have chosen. Work with Young Naturalists, for example, begins in the lower school grades. Under the teacher's guidance the children arrange nature corner or circle carrying out simple observations of plants, animals and seasonal changes in nature and learn to conduct simple tests and make deductions from them. Creative inclinations, technical trends and desires to construct and invent begin to manifest themselves at this age.

Art is also encourged in young children since it is the most and effective means for esthetic, moral and intellectual development. Its role is especially important in childhood. Children's choir of the Institute of Artistic Education of the Academy of the Pedagogical Sciences of the USSR is, for example, well - known both at home and abroad. The School of the Baltic Republics has also acquired valuable experience in teaching music. The Art Studio of Kiev Young Pioneer Palace, which was founded almost two decades ago, is also of a national - wide reputation. Drawings by children of the Soviet Union have been exhibited in many countries of the world and have won general acclaim at the World's Fairs in New York, 1939, Brussels, 1958, and Montreal 1967. The special session, of the general meeting of the USSR Academy of Sciences in October, 1962, and the enlarged sitting of the Aasdemy's Presidium in October, 1963, were landmarks in the organization of the intellectual contacts between Soviet outstanding personalities working in both natural sciences and mathematics on the one hand, and the eminant artists, writers and humanists on the other. In the same year the first All-Union symposium for the comprehensive study of creativity in the field of art was held in Leningrad. The second symposium which was held in 1966, was deveted to the discussion of "Creativity and Scientific Progress Today."

In concluding this section it is of signifance to mention that there are, apart from ordinary general secondary schools, specialized secondary schools of art for creative children. Some specialized schools also and specialized classes in some secondary schools have been formed in which special stress is placed on the study of mathematics, physics, chemistry or biology and foreign languages. In all of these schools the study of the regular subjects is unchanged, making it possible for a pupil to transfer back from one of these specialized schools to an ordinary school. They are not for a chosen few-an intellectual elite. They are for children who reveal a special interest or talent in these subjects. Enrollment in these schools is on a democratic basis. One method of discovering talented children that has been especially successful is the annual nation-wide school contests in either mathematics, physics, chemistry, biology, history or literature. Millions of school children enter these contests on a voluntary basis. Those who take top honours have the best chances to enter specialized schools. However, the greatest emphasis is placed on the interview the teacher has with pupils who wish to enter these schools. The interview is not an examination, but is conducted as a friendly talk which helps to determine that interests and inclinations of each pupil.

There is a deep psychological effects for extra curricular activity connected with sensation and cognition which are to be stressed at the concluding part of this section. It is well-known that the growth of sensation and perception is a necessary prerequisets for the developing more complex intellectual processes in the child. Because of the development of the sensory processes figures so largely in the shaping of intellectual abilities, it is intrinsically vital in furthering the child's ability to handle practical activity. This is essentially based on current Soviet psychological and physiological research which, in distinction from the receptor theory of sensory impressions which prevailed in psychological and educational theory in the West, indicates that sensation and perception – expressed physiologically as reflex type actions – display unique orienting functions. An analysis of experimental data indicates that the process of perception includes not only receptor and cerebral central components, but, as already stated, effector components as well. This approach is sharply distinct from that of the West.

The Western educational systems of Froebel Montessori, Decroly and others have been subject to a sound critique by a number of Soviet educators who introduced many worthwile proposals intended to reconstruct sensory training according to the aims and principles of the Soviet preschool education. While Froebel's system was based on the idealist metaphysical conceptions of German psychology, and Montessori on the dualist theory of the psychophysiology of the sense organs proposed by Fechner and Wundt, the Soviet system of sensory training is rooted in the findings in sensation and perception acquired by Soviet materialistic psychology. The research studies that Soviet psychology has conducted proceed from the scientific theory of reflection or knowledge, while the interpretation of the physiological mechanisms of sensory processes is one that makes use of Pavlov's theory of reflex activity.

Froebel, Montessori and Decroly – despite of their differences- operated from the mistaken psychological premise that the basic sensory abilities exist in a ready-made form at birth. They thus reduced sensory training to ways in which these abilities are given practice. Soviet pre-school educaional theory, drawing on current findings in Soviet psychology, regards sensory development as the development of new processes and abilities that the child does not have at birth but which he acquires under the influence of an active programme of instruction. Organically, this is equipped with some of the prerequisites for sensory development inherent anatomical and physiological features peculiar to one or another type of analyzing system –, but to develop the distinctly human sensory abilities he will need later in life, to do work that is materially productive, or pursue some scientific or artistic interest, his training cannot be confined to the mere exercise of his sense organs. His ability to handle sense data must be moulded through training based upon a specific scheme of instruction. This view of sensory development allows for a different approach to the problem, even for a thorough reappraisal of traditional programmes of sensory training. As a rule these programmes were uneven. They tended to exclude activities that would develop such abilities as musical and phonemic hearing, for instance. On the other hand, as Soviet psychology and physiology have shown, infants in their first six months of life can distinguish objects in terms of shape, size, etc. Hence, any system which trains children between 3 and 7 years of age in similar types of differentiation can hardly be conductive to furthering the child sensory development.

We can now define more precisely what the principal points of difference are between the Soviet system and the formal didactic system of Montessori on the one hand, and between Decroly's on the other. In Montessori's the focus of attention was mainly on training children how to distinguish or recognize artificial abstract forms which had been selected for teaching purposes. Under that system, however, children were not taught how to use such forms as standards they might apply when trying to isolate and reproduce qualities they perceive in reality. By way of reaction to Montessari formal didactic method, Decroly tried to acquaint children with the diversity of forms, colours, and sounds to be found in the world. But on the whole he failed to equip the child with a means of becoming oriented to his surrounding. Consequently, both these systems-Montessori's and Decroly's – were completely unsatisfactory, for they did did not provide tasks that would consistently develop methods by which a child could orient himself to the world of perceptual phenomena. The Soviet programme of sensory training, on the other hand, provides ways in which the child will successfully master a system of conventional standards of sense data. He is taught how to use these standards effectively to analyze and synthesize the qualities he perceives in the surrounding objects. This use of standards requires that, in addition to a knowledge of sensory pattern-graphic ideas about the basic colours or elementary forms, for instance – a child be able to compare these with qualities in real objects, and that he also be able to detect other relationships between the parts of objects.

From the Soviet psychological point of view, not only touch and sight, but other types of perception are carried out by means of special orienting functions which model the features of a given object. Recent Soviet research indicates that from infancy on a child's sensory functions undergo a lengthy course of development and are progressively improved. Specifically, the cognitive functions which he has performed, originate and develop under the control of vision. However, the question remains: what does the hand contribute to sight, not as an organ of touch, but as one which manipulates and performs practical operations with objects? Apparantly some important qualities of visual perception, such as objectivity and a sense of spatial dimensions of an object, are acquired through the aid of touch. At the same time, one should not minimize the role which sight plays in developing a child's capacity to manipulate objects and perform practical operations with them. At a very early stage in life it is the eye which begins to deal afferently with mannual operations. Similar data on the way children develop orienting functions during the preschool period were obtained in research on tonal and phonemic hearing, and in studies on motor and kinesthetic perception. However, the child sensory functions will not develop in this way in isolation. Such growth can only take place under the influence of practice and instruction in using the common sense data one acquires. If sensory training is allowed to take its own course, and no organization is imposed on it, the results are not too productive. The process will be considerably more effective if the child is specifically taught methods he can use to examine objects, and suitable standards to apply to the sense data he acquires. This is the only sound foundation for the development of mental processes which begin, as already stressed, with certain external operations that an individual performs with objects. Subsequently, given certain conditions, this process acquires an orienting, cognitive function which, once it has undergone a series of changes and becomes contracted, is ultimately converted into an internal operation, one that takes place on the plane of ideas.

Speaking in general terms, in the general course of the child's development, an important place is occupied by the development of the motor sphere, of movement and motor habits. Thanks to the development of the motor sphere there is an increase in the contact of the infant with the surrounding world. In Soviet child psychology, immediate practical activity is held to be of great significance for mental development. Therefore, it is natural that a good deal of attention should have been devoted to the study of the development of movements and motor habits. The early age periods of life are periods of the dominance of the direct sensory cognition of reality. Naturally, attention has also been devoted in Soviet child psychology to the study of the development of perception. The problems of the development of thinking at junior age, specifically at preschool age, have interested Soviet psychologists, not only with the aim of discovering the features of the development of thinking, at these ages, but also because such research casts light on the nature and origin of thinking in general as we shall see later. The research of Galperin during 1950's has brought to light the origin of the earliest manifestations of thinking. He demonstrated that the emergence of intellectual operations in the child is bound up with the developing use of implements in practical activities. At the same time it was shown that the intellectual operations are initially isolated from practical activity and then begin to serve the latter.

In connection with what has been said in this concluding part of this section it is important to mention the formation of a new branch of psychology in in the USSR : engineering psychology. In the 1950s, increasing emphases began to be placed on the rational use of human skills, especially as these skills interacted with newly developed machines. In 1959, the first University Laboratory of Engineering Psychology was opened at Leningrad University (under Lemov's direction). Shortly thereafter laboratories opened at Moscow University, Kharkov University and other Institutes of Psychology. Today engineering psychology is one of the most energetic and sophisticated branch of Soviet psychology.

Numerou Physiological and psychological investigations (especially Bernishtein's and Anokhin's) have revealed certain concrete laws of the reflex mechanism of the motor act, the role of the sensory correction and reverse afferentation and certain characteristics of neurodynamics. The human hand is a complex control system with reverse – feedback – connections in which kinesthetic and tactile analysers play a basic role. Accuracy and speed of hand movements are determined not only by muscles tissues and muscular structure, but primarily by the characteristics of the process of the circulation of the control information – the time of the regulatory cycle, the time of switching, the structure of the directing signal, etc., –. The kinesthetic links become fully associated, and the movements coordinated, because in the synthesis of conducting signals, superfluous freedom of the moving organs is overcome. Even the simplest work action is formed from a more or less substantial mass of elementary movements, united by the regulatory mechanism into a complex structure. These movements may by divided into three groups according to their functions : the first group consists essentially of work – execution – movements by means of which the object is influenced. The second group involves gnostic movements. The third group consits of adaptive movements. The interrelationships between these forms of movement change in the process of habit formation. Gnostic movements are usually predominant on the first level. Later they are reduced and are so intimately merged with the working movement that it is often difficult to separate them.

So far we were talking about the directive actions of the human operator. Now it is time to stress the process of operative thinking, that is, the process of solving practical task, which results in the formation of a model of action – plan of operations – which will ensure attainment of the requisite goal. It includes clarification of the problem situation and the system for its mental and practical solution. The need to solve problems which arise in the course of control processes occupies a central place in the operator's activity. The operator, participating in complex control systems, must deal with problem situations which he must interpret, analyse and solve. The problem of operative thinking was first discussed in detail by Teplov, using the activity of a military general as an example. Teplov showed that the well-developed practical intellect is characterized by an ability to quickly analyze a complex situation and almost instantly find the correct solution. Teplov's conclusions are extremely interesting for engineering psychology because the operator's activity is in many ways analogous to the activity of the general-complex situation, insufficient time, the need to keenly evaluate opposing forces, great responsiblity for every decision –.

There is also the operator's memory in addition to the directive actions of the human operator, and the operative thinking already stated. All of the basic types of memory appear in some form or other in the activity of the man who controls machines with instruments. Operative memory is understood as the momentary retention of information necessary for successful solution of problems of current activity and the achievement of its goal. The problem of the operator's memory is being intensively and productively investigated in Kharkov University Laboratories.

In the light of what has been said so for it is clear now that it is impossible to ensure high reliability of control systems without taking into account the peculiar activity of the human operator. Man is significantly better than any existing machine. He can cope with the unexpected, he can forese the course of events, find optimal solutions in complex situatoins and transform the method of activity in new conditions. At the present time there is a strong tendency toward complex investigations of man. In particular, engineering psychology is passing from the solution of the individual probelsm and analytical investigations of separate aspects of man's activity in control systems to the development of general concepts of its structure and dynamics. In this connection it is inevitable that the contacts between engineering psychology and related sciences will be increased. The complex approach to the study of man transforms the special problem of engineering psychology : man as the corner – stone of control systems – to more general problems : man as the subject of work, recognition, generalization.

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SECTION III

General Conclusions

A : Environmental Factors Generating Creativity.

B : A Tentative Hypothesis Regarding Brain Mechanisms Of Creativity and Genuis

A : Environmental Factors Generating Creativity

We all know that man comes into the world as a veritably helpless being with extremely primitive means of receiving stimuli – receptor organs – and extremely meager means for expressing reactions – effector organs – . It is also well-known that everyone of the constituent elements of human society is born immature, helpless and without any social ideas or mental processes. And it is clear that there is, on the one hand, the contrast between the immaturity of the new born members of society – its true sole representatives – and the maturity of the adult members of society, who prossess knowledge, activity and all forms of mental life. On the other hand, there is the necessity that immature members be not merely physically preserved in adequate numbers, but also that they be initiated into the social life of the mature members. Otherwise, society will cease its characteristic life. Even in a savage tribe, as Dewey observed many years ago, the achievements of adults are far beyond what the immature members would be capable of if left to themselves. With growth of civilization, the gap between the native capacities – unconditional reflexes – of the infant and the higher mental functions of the adults increases immensely. In fact, the human infants are so immature that if they were left to themselves without care and succor of the elders, they could not even acquire the rudimentary abilities necessary for physical existence. Infants compered so poorly in biological efficiency with the young of many lower animals, that even the powers needed for physical sustaintion have to be acquired in the course f life. How much more, then, is the case with respect to science, technology and all forms of human social activity !!.

Accordingly, human mental processes are formed by means of the action of the social environment in calling out certain responses. The particular social medium in which the child exists leads him to see and feel one thing rather than another and thereby strengthens certain responses and weakens others as a condition of positive reinforcement, that is, wining the approval of others. Thus, the social medium consists of those conditions that promote or hinder, evoke or inhibit the characteristic behaviour of the infant. Even animals, have their actions modified by association with human beings who control them indirectly through – controlling their environment.

A tribe, let us say, is warlike. The success of which it strives, the achievements upon which it sets store, are connected with fighting and victory. The presence of this specific social medium incites bellicose exhibitions in the child, first in games, then in fact when he is mature enough. As he fights he wins approval and social advancement. When he refrains, he is diliked, ridiculed and excluded from favourable recongnition. Likewise, a child growing up in a family of musicians will invevitably have whatever inclinations he has stimulated towards music. Otherwise, he becomes out of the family, unable to share in the life of this group to which he physically belongs. However, the infant is not passive regarding the social life of his society. His active role cannot be better put in Western thought than in the words of Dewey:(1) "The primary condition of growth is immaturity... The prefix "im" of the word "immaturity" means something positive, not mere void or lack. It is noteworthy that the terms "capacity" and "potentiality" have a double meaning, one sense being negative, the other positive. Capacity may denote mere receptivity, like the capacity of a quart measure.. We may mean by potentiality a merely dorment or quiescent state: a capacity to become something different under external influences. But we also mean by capacity an ability, a power; and by potentiality potency, force. Now when we say that immaturity means the possibility of growth, we are not referring to absent power which may exist at a later time; we express a force positively present – the ability to develop. Our tendency to take immaturity as mere lack, and growth as something which fills up the gap between the immature and the mature is due to regarding childhood comparatively instead of intrinsically. Taken absolutely, instead of comparatively, immaturity designates a positive force... The specific adaptibility of an immature creature for growth constitutes his plasticity. This is something quite different from the plasticity of putty or wax. It is not a capacity to take on change of form in accord with external pressure. It lies near the pliable elasticity by which some persons take the color of their surroundings while retaining their own bent. But it is something deeper than this."

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(1) Dewey, J., Democracy and Education, New York, Macmillan, 1961, PP. 49—53.

It goes without saying that there are inborn individual differences in higher nervous activity. But these inborn differences in higher nervous activity do not predetermine psychic development in an absolute way. The individual brain also functions under the influence of its surroundings, and human mental processes, being reflection of the objective reality, are also formed and developed under this same influence. Individual brain also functions under the influence of its surroundings, and human mental processes, being reflection of the objective reality, are also formed and developed under this same influence. Individual behaviour is not, therefore, the simple expression of natural endowment, independent of external influences. It has a physiological basis in the system of temporary connections formed as a result of the influence of the environment and the individual responses; these are not born but acquired during the individual life experience. Moreover, Pavlov researches have demonstrated the extreme flexibility of the nervous system in the forming these connections which constitute the basis of human psychic activity and are always, strictly determined by objective conditions. "The chief, strongest and most lasting impression we get from the study of higher nervous activity" wrote Pavlov", (1) is the extraordinary plasticity of this activity, its immense potentialities; nothing is immoble, intractable, every-thing may always be achieved, changed for the better, provided only that the proper conditions are created." It follows that conditions of social life play the decisive part in man's psychic development. These always depend on society and are determined not by individual biological inclinations, but by the historically determined material life of society in which he lives and has his social being. This is the fundamental premise where it is a question of investigating what determines man's psychic development. However, the conditions of life do not determine psychic development automatically, of themselves, simply by virtue of their existence. Under the same conditions development may take place in different ways. This depends on the place these conditions occupy in the life and activities of the individual, the way in which his life unfolds in them and what is his attitudes towards them. Psychic development takes place on the course of interaction between human beings and objective reality. A man is not the passive object of the influences of his surroundings, but an active participant in them, and a change in the conditions of life entails a change in individual development.

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(1) Pavlov, I.P., Selected Works Moscow, Foreign Long. pub. House, 1955, PP. 446—447.

If a child's psychic development is to be correctly judged, it is necessary to study him under conditions which create the necessary motivation for his activity and his definite attitude towards it. Only then is it possible to ascertain what abilities the child actually possesses, and this should be the path taken by psychology. Psychology must assist men to develop their valuable qualities, and to form useful ones that may not always be adequately developed. People are the most precious capital in the world. To care for human beings is the sacred duty of every science and every scientists, and the most valuable contribution that psychology can make towards solving the problems of human beings is to make scientific and realizable plans for all-round development of human mental functions of all individuals. The role of school education in this respect is crucial. When traditional educationists think of the docility of the young they first think of the stock of information adults wish to impose and the ways of action they want to reproduce. Then they think of the insolent coercions, the insinuating briberies, the pedagogic salmnities by which the freshness of youth can be faded and its vital creativity dulled. Education becomes the art of taking advantage of the helplessness of the young instead of being a means of stimulating original thought and of evoking action deliberately adjacent in advance to cope with new forces. In schools, those under instruction are too customarily looked upon merely acquiring knowledge possively, or absorb information directly through pure contemplation and their bodily activity becomes an intruder. Having nothing to do with mental activity, it becomes a distraction, so it is thought, an evil, to be contented with. The chief source of the problem of discipline in school is that teachers have often to spend the larger part of the time in suppressing the pupil's activity which takes the "mind" away from its material. The nervous strain and fatigue which result with both teacher and pupil are a necessary consequence of the abnormality of the situation in which bodily activity is divorced from the mental life of the individual. On the other hand, there is, as Dewey observed, no inconsistency in saying that in schools there is usually both too much and too little information. The accumulation and acquisition of information for purposes of reproduction in recitation and examination is made too much of. Frequently it is treated as an end in itself, and then the goal becomes to heap it up and display it when called for. This static cold-storage ideal of knowledge is inimical to creativity. It not only lets occasions for creativity go unused, but it swamps creativity. "No one could construct a house on ground cluttered with miscellaneous junks. Pupils who have stored their minds with all kinds of material which they have never put to intellectual use sure to be hampered when they try to create. They have no practice in selecting what is appropriate, and no criterion to go by; everything is on the same dead static level". (1) "No one can carry around with him museum of all things whose properties will assist the conduct of his creative thohght. A well-trained mind is one that has a maximum of resoures behind it, so to speak, and that is accustomed to go over its past experiences to see what they yield... Excesive reliance upon others for data-whether from reading textbooks or listening to teachers is to be depreciated. Most objectionable of all is the probability that others-books or teachers-will supply solutions ready-made, instead of giving material that the student has to adapt and apply to the problems facing him. This state of affairs hampered many potential creative youngesters. Newton was for a time bottom in the lowest form at the Grammar achool at Granthan. He was inattentive and a bad scholar. James Watt was excelled neither in lesons nor in games, and was described as being dull and inept. Some of his teachers thought that he was backword for his age. Pasteur was a mediocre pupil and was thought by his father and teachers to be mediocre. His father was concerned about his future. His father, who was a teacher living in the Jura mountains near-the Swiss frontier, hoped that his son would be a teacher. Rontington was not a bright pupil. Eddison was always at the bottom of his class, and his father thought he was stupid. One day his teacher said that his mind was addled. The boy heard it, stormed out of the class and refused to return. Poincare's score of the zero in the school enterance examination in drawing almost made him fail in the interance test to Higher Teachers Training College in Paris. Leonardo da Vinci neglected his school studies because of his interest in nature, and the immense store of knowledge which he accumulated later was self taught. He early decided to be an investigator, teacher and artist. He begged his father to apprentice him to painter, but his father refused because painters were regarded as inferior, and his father wanted him to be a lawyer. At eighteen, however, Leonardo became apprentice to Anderea del Verrocchio, the Florence painter, sculptor and architect. Leonardo came also under the influence of Toscanelli, naturalist and mathematician. Michelangelo's father was annoyed at his boy's repeated request to become an artist. He has displayed his passion for drawing from the earliest years The father intended that his five sons to go into business and become bankers. He beated Michelangelo and scolded him, but failed to shake him out of his ambition. The boy was sent into the country to be looked after by the wife of a stone mason. There Machelangelo covered the walls of the stone mason's house with sketches. Balzac was given up by his teachers as a failure. One of them said: "This fat little fellow goes around in a state of intellectual coma." He was idle and disobedient, and was sent to another school, where his behaviour was not better. Emile Zola was a poor student at his school at Aix, and he was no better at Ecole Normale in Paris. He cut his classes and refused to recite when called upon. He devoted all his time to writing poetry and reading but in his final examination he scored zero for literature. Leo Tolstoy had many troubles at school. His teacher said of the three brothers that "Sergi is willing and able, Dimitri is willing but unable and Leo both uniwilling and unable to learn; he would not concentrate on anything but poetry".

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(1) **Dewey, J., Democracy and Educational, New York, Macmillan, 1916, P. 186.,**

Alexander Von Humbalt and his brother Wilhelm, two year older, were privately tutored along the usual classical lines. Wilhelm liked languages and was early recognized as gifted. Alexander, caring only for nature, was considered mentally slow. Both became eminent, but Alexander outstripped his brother. Pascal was exremely weak in all his school subjects, especially Latin and Greek. He was so absorbed in mathematics that his father thought best to deprive him of books on this subject until he had first mastered his Latin and Greek. When Samuel Johnson was a child one of his teachers said of him in her old age "never was so dull a child". Sir Walter Scott is said to have been a dunce when he attended the Musselburgh school. When he was seven he read widely in poetry and by age ten he had collected a small library of ballods and at thirteen he lay awake night reading Shakespear when he was supposed to be asleep. Leibig, the founder of physiological chemistry, was the despair of his teachers. At fifteen he left school and was apprenticed to a chemist. John Hunter, the famous British surgeon and anatomist, was considered retarted in his school. He left it at thirteen and spent four apparently idle years roaming the woods and fields, presenting people around him with questions about which nobody knew or cared anything.

The story of Winston Churchill's school days is well-known. When his Latin enterance examination paper was handed in at Harrow it was found to contain nothing but a figure one in the brackets, two smudges and a blot. The headmaster accepted him because he did not think the lord Randolph's son could be so stupid. He passed into Harrow at the bottom of the lowest form and never moved out of the lower school for the whole of the five years he was there. He remained perpetually bottom of the class and did not excel in sport. At his former school he had been described by his teacher, Miss Moore, "as a small red-heeded pupil, naughtiest boy in his class." Churchill wrote about his school days in Harrow: "My teachers saw me at once backward and precocious, reading books beyond my years and yet at the bottom of the forms." In his book: My Early Life,(1) in addition to describing his own unhappiness at school, he made many imporant comments on education in general. He hated his preparatory school, where he made very little progress at his lessons and none at all in games. Floggings were severe and frequent. Looking back on his school days as a whole, he wrote: "I was considerably disccouraged. All my contemporaries were better at games, and lessons. It is not pleasant to feel oneself so completely out-of-class and left behind at the very beginning of the race. In retrospective these years form not only the least agreeable, but the only barren and unhappy period of my life. This interlude of school makes a somber grey patch upon the chart of my journey. It was unending spell of worries that did not seem petty, and I toiled uncheered by fruitation; a time of disconfort restriction and purposeless monotony... When may reason, imagination or interest were not engaged, I would not or could not learn... In all the twelve years, I was at school, no one ever succeeded in making me write a Latin verse or learn any Greek except the alphabet... Examination were a great trial. The subjects which were dearest to the examiners almost invariably those I fancied least. I would have liked to have been examined in history, poetry and writing essays. The examiners, on the other hand, were partial to Latin and mathematics, and their will prevailed. I would have liked been asked to say what I know. They always asked me to say what I did not know. When I would willingly have displayed my knowledge, they sought to expose my ignorance." Churchill said that he was always glad that he learned English at Harrow. The clever boys studied Latin and Greek, and the dullest English.

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(1) London, Odhams, -959.

Darwin wrote vividly in his Autobiography, "Nothing could have been worse for the development of my mind than Dr. Butler's school, as it was strictly classical, nothing else taught except a little ancient geography and history. A school as a means of education to me was simply blank... When I left the school I was for my age neither high nor low in it; and I believe that I was considered by my father as a very ordinary boy rather below the common standard in intellect. To my deep mortification father once said to me: You are good for nothing but shooting dogs and cats catching, and you be a disgrace to yourself and all your family. But my father, who was the kindest man I ever knew and whose memory I have withhold with my heart, must have been angry, and somewhat unjust when he used such words. Looking back as well as I can at my character during my school life, the only qualities which at this period promised well for the future, were, that I had strong and diversified tastes and much zeal for whatever interested me, and a keen pleasure in understanding any complex subject or thing... With respect to my diversified tastes, indepenently of science, I was fond of reading various books... Early in my school days a boy had a copy of the Wonders of the World, which I often read and disputed with other boys about the varacity of some of the statements; and I believ that this first book gave me a wish to travel in remote countries, which was ultimately fulfilled by the voyage of the Beagle. In the latter part of my school life I became passionately fond of shooting; I do not believe that any one could have shown more zeal for the most holy cause than I did for shooting birds... With respect to science, I continued collecting mineral's with much zeal... As I was doing no good at school, my father wisely took me away at a rather earlier age than usual and sent me to Edinbrugh University... The instruction of Endinbrugh was altogether by lectures, and these were intolerably dull with the exception of chemistry". (1)

Alfred Adler, the psychologist, was so poor at mathematics that he had to repeat the work of his form. His teacher advised his father to remove him from the school and prentice him to a shoemaker, because he was not fit for anything else, but his father let him stay at school, and the boy worked hard at mathematics. Subsequently, when the teacher wrote a problem on the blackboard, which none of the pupils could solve, Adler stood up and said that he could solve it. The teacher made sarcastic remarks, but let him try, amids the laughter of his schoolmates, he solved the problem suscessfully. Picasso was said to be able to draw long before he could speak. When he was ten his father became an art master, and the boy spent all his time painting and drawing under his father's direction. When his father

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(1) Darwin, Francis, editor, Life and Letters of Charles Darwin, London, John Murray, 1887, Vol. I, PP. 31—34.

acquired a post at the Barcelona School of Fine Arts, the boy, now aged fourteen, was allowed to miss the initial stages and sit the examinaton to enter the next class. When he was sixteen he had taken all the tests at the Spanish schools. He said that the life in the streets was of much greater interest to him than the courses laid down by the professors at the Academy in Medrid.

One of the most tragic plights witnessed among highly creative individuals stems from the failure of their teachers and fathers to understand them. Frequently destructive or incapacitating hostility is the result of this failure. When teachers fail to understand highly creative children, refusal to learn, delinquency or withdrawal may be the consequence. It is a legitimate function of the home and school to provide the experience and guidance which will free these children to develop and function fully. Many parents attempt too early to eliminate fantacy from the thinking of the child. Fantacy, which is a normal aspect of a child's thinking, must be kept active until the child's intellectual development is such that he can engage in sound creative thinking. Moreover, parents are frequently irritated by the unending curiosity and manipulativeness of highly creative children. Endless questioning and experimenting be treated as inconventient and persistent questioning are considered annoying. Parents should help the child learn from his questions. They also should permit their children to learn on their own. Individual administration of problems involving possible solutions to frustrating situations has shown that the imagination of many children is inhibited by the tremendous emphasis which has been placed on prevention. They must try, fail, try another method and, if necessary, try even again. Of course, they need guidance, but they also need to find success, by their own efforts. Each child strives for independence from the time he learns to crowl, and independence is a necessary characteristic of the creative process.

In the Western school at the present time, it is perfectly true that the school usually starts with an assembly of all the children. But for the main business of the school-that is for teaching – there exists not one school, but several different "schools". These "schools" within a school can best be likened to conveyor belts, moving at different speed, and moving also progressively further apart. Schools are described as two-stream(1) schools or three-stream schools and even four, indicating the number of parallel classes for the different years, and implying, not only movement at a different pace, but also the existence of banks separating one stream from the other.

Streams are normally called A, B, C, D. "A" stream is the quickest and "D" is the slowest. Once a child is placed in one of these categories, he is almost certain to remain in it as long as he stays in his school. Streams are based on intelligence tests which are supposed to measure child's inborn intelligence since his capacity to profit from education is supposed to depend on the amount of intelligence he possesses.

In the Summer of 1970, Arthur Jensen, a well-known American psychologist, visited England to give a series of lectures about his latest findings in the field of intelligence. He argued that, owing to genetical endowment, blacks – negroes – in the United States are innately less intelligent than whites, and also that the working class whites are less intelligent than upper and middle – class whites. He claimed, in other words, that both racial and social differences are inherited and can be revealed through mental tests. As it is well-known that from the outset of mental testing, Western psychologists have been primarily concerened with the question of the distribution of intelligence among the whole population and the conclusion arrived at was that the distribution of intelligence follows a normal curve. Now it is clear that, since intelligence cannot even be defined, there can be no way of knowing how it is ditributed. In other words, the psychologist conducts his test in such a way that it will tend to give a normal distribution of scores, and no other. And why is it so it is easily assumed that intelligence must be normally distributed!! the bent in favour of normal distribution is partly to be explained by the fact that certain physical characteristics, such as height, are normally distributed. This kind of argument by analogy has no scientific validity. It might just as well be argued that some physical characteristics – such as weight and hair colour – are not normally distributed. Furthermore, to interpret the fundamental nature of human mind by analogy from physical characteristics is an exceedingly dangerous proceeding since – the human mind – or higher nervous activity – presents a qualitative difference. On the other hand, there are crucial distinctions between measuring intelligence and, for instance, measuring height which is a single dimension and measurable. However, it may be argued that in school we find at the top

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(1) Streaming — or tracking as it called in the United States — is a device for grouping children into classes or groups for teaching purposes on the basis of their native intelligence or their so-called "abilities".

"A" stream a few highly intelligent children. At the bottom of "C" stream a few very unintelligent children, while the majority be between the extremes. But this argument shifts the discussion from intelligence to educational attainment. It is perfectly true that, in the Western society at the present time with he schools organized in their existing way, the children's educational attainment will tend to be distributed in this order. This arises from the whole selective system and the process of streaming as well as, of course, from the class structure of Western society. Moreover, intelligence tests isolate the individual from all social relations and from any real life situation – since the questions asked exclude any emotional response. This is done in an effort to isolate the so-called "pure" intelligence which Western psychologists seek to measure. In a life situation, the individual feelings play an essential part in his total response. They are equally involved even in the most standardized situation. Furthemore, do not people behave intelligently on some occasions and unintelligently on others? Intelligently over certain kinds of matters and unintelligently over others? What justification could there be for lumping all occasions and all types of behaviour together as functions of one common intelligence? Is in the measure of intelligence anything other than the measure of performance, from which intellingence is being inferred? How far could we then proceed to the argument that intelligence which is being measured is an innate mental ability?

The American investigator, Bronfenbrenner, already quoted, says(1) "It is noteworthy that, of the countries in which my colleagues and I are working... the only one which exceeds the United State in the willingness of children to engage in anti – social behaviour is... England... our competitor in troubled sensationalism, juvenile delinquency and violence... Only since 1968, with the publication and dramatic presentation on television of a national report on hunger in the United States, have we become aware of the extent of nutritional deficiency in our country... Such deficiency takes its greatest toll, of course, among children and pregnant mothers. A child in school cannot learn very much when his stomach growls for lack of breakfast, and there is no prospect of lunch. Far worse is the damage done to pre-school children and pregnant mothers... Similar considerations apply to the spread of disease". What is more important, I think, is the negative and destructive effects on the brain functions, and the net outcome is being at the lower levels in intelligence tests and school examinations.

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(1) **Two World Childhood, PP. 116—117.**

The above quotation means that a significant portion of American children is exposed to nutritional deprivation with all its negative influence on the intellctual growth referred to. In addition, there is evidence that nutritional deprivation early in life can effect subsequent bodily growth in general. A substantial body of evidence accumulated for some time indicates that children's health, physical growth and biological biological development are seriously and even permanently impaired by the combination of severe malnutrition, infection and parasitic diseases which are evidence in many regions of the United States and Western countries let alone the developing countries where conditions of extreme proverty prevail. Malnutrition early in life is not only a serious threat to children's health and physical development, but also has adverse effects on the social competence and all human mental processes. By the mid of 1960's, as this point of view was becoming quite prominent, it was based primarily on the growing evidence concerning reduced brain size and the number of brain cells in seriously malnourished children. However, while severe malnutrition clearly implicated as one determinant of impaired intellectual development, it has been extremely difficult to isolate this influence from that of various social, educational, family and child rearing conditions typically assocaited with malnutrition and capable also of exerting major influence on psychological development on their own right. On the other hand, malnutrition exerts its major influence on behaviour through dysfunctionl changes in attention, responsiveness, motivation and emotionability, in addition, of course, to direct impairment of basic learning and cognitive competencies, "The more serious manifestations are reflected in the rising rates of youthful drug absuse, delinquency and violonce documented in charts and tables specially prepared for the White House Conference on Children(1)". "According to these data the proportion of youngsters between the ages of 10 and 18 arrested for drug abuse doubled between 1964 and 1968. Since 1963, juvenile delinquency has been increasing at a faster rate than the juvenile population: over one-half of the crimes involve violence, theft or breaking and entry; and if the present trends continue, one of every nine youngsters will appear in juvenile court before age 18. These figures index only detected and persecuted offences. How high must they run before we acknowledge that they reflect deep and pervasive problems in the treatment of children and

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(1) Profiles of Children: White House Conference on Children, United States Government Printing Office, Washington, D.C. 1970.

youth in our society". (1) The following excerpts convey the essence of the argument: "We are experiencing a break down in the process of making human being human...... By setting priorities elsewhere and putting children and families last, by claiming one set of values while pursuing another ... This reversal of priorities which amounts to betrayal of our children underlies the growing disillusionment and alienation among young people in all segments of American Society... If this is not reversed... It can have only one result: the far more rapid and pervasive growth of alienation, apathy, drugs, and not in young, but in all segments of our national life. We face the prospect of society which resents its own children and fears its youth". (1)

Various estimates put the number of children living in poverty in the United States at the present time at from 11 to 15 millions, or 25 percent of all the children in the United States and up to 23 millions if teenagers are included. Thus, young people comprise over half of those living in poverty. Within the American Negro population, those under 21 years old account for 60 percent of the officially considered poor. According to data published in the President's Economic Report of 1969: 6,200,000 families and 4,500,000 single persons or a total of 30 million persons, were living at proverty level. Things could hardly be otherwise when the government was spending about 30 dollars a year on each poor person in the country, and 50,000 dollars a year on each American soldier in Vietnam.

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(1) Nurnberger, J. I., Editor Research Publications Association for Research in Nervous and Mental Diseases, Vol. 5, Baltimore. The Williams and Wilkins Company, 1973, P. 363.

(1) Report to the President: White House Conference on Children, United States Government Printing Office, Washington, D.C. 1970, Guoted By Nurnberger, J.I., op. cit., P. 365.

Contemporary state-monopoly capitalism regards education and, for that matter, all other spheres of social and cultural activity as well, primarily from the standpoint of its role in strengthening the private property system and ensuring higher profits. Many American statesmen and scholars who call for improvements in education use as an argument the fact that investment in this field will ultimately result in higher profits elsewhere. Manifest in the United States is the contradiction between the requirement of modern social progress for a steady rise in the educational level of the whole population and the inevitable desire of the state-monopoly capitalism to impede the education of the popular masses, especially the poorest sections. Therein lies the class character of the American educational system. Of course, the educational level of and the opportunities available to the working classes in the capitalist countries have grown immeasurably, but the class nature of the bourgeoise educational system has not changed despite the broader and more democratic social make-up of the students. The class character of American schools also manifests itself in the way education is financed: on the whole, 7.6 per cent of the fund for public schools comes from the federal budget, 38.6 per cent from the state budget, and 53.8 per cent from local taxes which take the form of a tax on individual family real estate. Especially, however, funds derived from property taxes paid by well-to-do families are not distributed to enhance the education of children from poorer families, since such funds go exclusively to support the schools located in the same neighborhood or school district in which they are raised.

The elementary and secondary school buildings in which children from families with an average annual income of less than 5,000 dollars are taught are, on the average, 50 years old, whereas children from families with an average annual income of 90,000 dollars go to the elementary schools that are only 10 years old. The poor districts account for the entire 36 per cent of the country's public schools that were built more than 50 years ago, and there are the districts in which the country's entire shortage of 14,000 classrooms is found. And it is the schools of the poor districts that employ the one out of every five American teachers who has no teaching credentials or has not completed the four-year college education required for such credentials.

Modern production demands from workers knowledge and skills which they lack and are unable to obtain; yet without these, their labor power loses its value and can find no application. It turns out that the people at the bottom of the social ladder in the modern American capitalist society are poor because they are insufficiently educated, but cannot receive the necessary education because their parents are poor. This contradiction manifests itself to an even greater degree when it comes to the question of receiving a higher education. The lower strata of American society cannot afford to send their children to private schools where the tuition fee is about 1,000 dollars a year. But the graduates from private schools have the best chances of entering universities. Equal opportunities are lacking even in public schools. The theory of inn te intelligence is widely used there. Secondary schools-or high schools as they are named there – are divided into three groups: academic, general and vocational. The selection of students depends largely on financial position of the family – whether it can afford the cost of higher education. At that moment, the future of a youngman is largely decided, since the academic group has much greater chances to go on to college. No wonder, then, that at present less than one million out of the more than seven million students in universities and colleges come from working-class families. Once in college, youngesters who come from the lower strata of American society are under constant pressure to drop out. Of all students who enter colleges, about 40 per cent do not complete their studies, but among students from working-class families the rate is more than 85 per cent. Here, too, the reason lies primarily in the high cost of university education, which to make things worse, is growing from year to year. The average of a college education in the United States today is close to 4,000 dollars a year, that is, 16,000 dollars for a four-year course- and just for one person. The family that has three or four persons could well spend 50,000—60,000 dollars for their college education. However, in private colleges the education costs are higher still.

Many schools and classes in the West recruit pupils according to their mental ability, the so-called "intelligence quotient" which is established by various intelligence tests. This antipedogogical system determines the future of children when they are between 11 and 15 and only a minority of them are recognized as fit for academic studies, while the rest are considered only good enough for practical work. The children of working people usually end up in the average and low quotient categories. The children of wealthy parents, having better opportunities to prepare for the tests, find their way into schools where the level of education is higher and subsequently enrol in colleges or universities. So, besides high education costs, the children of working people are confronted with a humiliating business – of having their capability to continue education officially denied. It is scientifically established that every normal child possesses an immense psychophysiological potential. The realisation of this potential largely depends on the social environment especially education.

American progoganda frequently tries to justify the defects in the country's educational system by placing the blame for their existence on the working people themselves. Unemployment and poverty in the country as well as other social ills are attributed to the lack of interest in education among youth, early marriage, lack of imformation about the advantage of higher level of education, etc.

Among the reasons for the crisis in American higher education are anti-intellectualism, a pragmatic approach to educational goals, and the trend towards narrow specialization which may yield definite practical results in preparing the student to satisfy the immediate needs of a capitalist enterprise, but in the long run it is unprofitable both for society and the individual. Due to rapid development of modern technology, the specialist, trained only ten years ago, can find himself at a dead end. Today, higher education's dependence on monopoly capital in the United States has assumed a universal character. For instance, the University of California, Berkeley, Board of Regents represents the interests of 68 leading banking, industrial, insurance, agricultural, commercial and mass media corporations. The financing of Harvard University is effected by 31 corporations and its general policy is determined by 76 corporations. The same holds true for every major university and college in the United States. The influence of state-monopoly capitalism upon the activity and research carried on at the American Universities is growing. This process is closely linked with the increasing dependence of American universities on military-industrial complexes. A primary function of the universities is the training of personnel for corporations, institutions and agencies involved in war production : about 50 per cent of all research done in nine of the country's leading institutions such as the University of California, Stanford University and the Massachusetts, and California Institutes of Technology, is directly related to military needs of the government. State-monopoly capitalism's dominance over higher education has led to a situation where many leading universities emphasize in their research programs study of "strategic" countries, that is, countries which are of special interest to American imperialism from a military, political and economic standpoint.

The clearest of the dependence of American universities on the military — industrial complexes is the make — up of the autocratic boards of regents, trustees, supervisors, and so forth, which include executive of such corporations as General Dynamics, Lockheed Aircraft, General Electric, United Aircraft, American Telephone and Telegraph, Boing Aircraft, General Motors.

How can we judge the worth of any society from purely pedagogical point of view? The answer is legitimately, I think, the concern of one generation for the next. If the children and youth of a nation are afforded opportunity to develop their capacities to the fullest, if they are given the sound knowledge to understand the world in which they live and the wisdom to change it for the better, then the prospect, for the future is bright indeed. In contrast, as a society which neglects its children, however well it may function in other respects, risks eventual disorganization and decline. Now let us take another look, within the framework of this perspective, at the school systems in the United States and the United Kingdom on the one hand, and in the Soviet Union on the other – which we have previously detailed.

It is argued that the development of the mass media — the press, films, and television – , of a wider network of schools and the allegedly decisive attempts to overcome the existing system of education for the elite in a number of Western countries serve to lessen the difference between a mass culture and the culture of the privileged classes. The wrold-wide scientific and technological revolution has brought about a general rise in the cultural level and this, they claim, has made culture accessible to all. The development of the mass media in modern society and the growing demand for a higher level of education among the broad masses of population are undeniable. However, this does not change the ideological content or the political orientation of Western culture. In an antagonistic society there is not and can not exists equal access for all the cultural values and education. The desire to liquidate the system of elite education remains, in Western countries, as a dream of the best, most progressive teachers and public figures. Notwithstanding the changes which have taken place in the educational system in developed capitalist countries over the past years, their school remain class establishments. The unequal financial support, even within the system of state-run schools in those countries is a well-known fact, with schools in high income areas being allotted greater budgets, better buildings, modern equipments, and better trained teachers, as previously stressed. In the United States, for instance, the per capita school budget for children who live in wealthy subrubs is ten times that for children liviling in city slums. The class nature of education most markedly manifest in the existence – independently of state-run school-of private schools with tuition fees. Ten per cent of all children of school age in England attend such schools, with the figure for the United States 12 per cent. The fees these schools charge are very high making them assessible only to children from the highest strata of society. These schools serve the sociological function of differentiating the upper class from the rest of the population and train the future captains of the capitalist society. Thus, in England today 87 per cent of the generals, 83 per cent of the bishops, 85 per cent of the judges, 95 per cent of the top Foreign Office officials and 67 per cent of the higher civil servants were educated in privileged public schools. The use of intelligence tests which, as well-known, are neither objective nor scientifically justified, serves the same class purpose. In the end, only children from the well-to-do families receive a full education, while children from the working class homes receive only that minimum of education necessary for their future as workers in modern production. While giving the working people's children a minimum of knowledge, the ruling classes of the capitalist society at the same time set up the ideological conditions of the youth to adjust themselves to the existing social order.(1)

In August 1963 the Central Advisory Council for Education in the United Kingdom was asked by Sir Edward Boyle, then Minister of Education to consider primary education in all its aspects. The investigation began soon afterwards, in October 1963, under the chairmanship of Lady Plowden(2) and the report was concluded in 1966 and published in 1967. Part four examines the structure of primary education and divides the 20,000 schools surveyed into nine categories: In the first category were placed schools described as in most respect as schools of outstanding quality. This category contained 109 schools...representing one per cent of the total primary schools population. Concerning secondary education the Newsom Report says "We find many different kinds of social problems, a high proportion of mental illness, high crime and delinquency rates; and above average figures for infant mortality, tuberculosis, child neglect and cruelity. In and about the squalid streets and narrow courts, along the landings and stariricases of massive blocks of tenement flats which are slowly replacing the decayed terraces, outside garish garish pubs and trim betting shopes, in the lights of coffee bars, cafe's and chip betting shops, in the lights of coffee bars, cafe's and chip almost bored casualness the easy goals of group hedonism... We asked the heads of schools included in our survey to write freely about their problems. This is some of what the had to tell us... From London: "the neighbourhood presents a sorry picture of drab tremble-down dwellings in narrow mean little streets, relieved by open spaces made recently by demolition experts, and dreary bombsights that have served as rubbish dumps since the last war... Overcrowding still persists in remaining slum dwellings where people of all nationalities compete for shelter. The homes of our children are in deplorable conditions, Damp and badly maintained, many of them are over-crowded. Large families live in two or three rooms. Toilet requirements are inadequate, giving rise to difficulties through too much sharing." From the Middlands." The school is situated alongside a large sauce and pickle factory, and there is also a large brewery just behind it. The odours of vinegar and beer are constantly present and the air is full of soot particles"... From Yorkshire: "The area has one exceptionally high deposite of industrial dirt. The school itself has for neighbours two works within the twenty yards of the playground wall, and three more within a radius of 200 yards. A railway and a canal are also within 50 yards of the school. Houses are terraced in dirty and badly illuminated streets and most are due for demolation. This has, in fact, already started in some streets in which a number of uninhebited houses offer tempting opportunities for mischief. Only one to two per cent of the houses have indoor sanitation... A large portion of fathers spend their working life in an atmosphere of heat, dirt, noise and mechanical violence. Communication can only be carried out by shouting and the effect of this can be noticed in home, in the street and in the places of entertainment. There is, therefore, a great tendency for boys to shout at each other in ordinary conversation... The girls accept drunkness as part of normal pattern... They are amused by it; and regard it as the normal way in which to celebrate. Even in good homes the parents will provide cases of beer for a 15 year-old's birthday party... In some way they regard bad language as the normal procedure... Many of the "fringe" groups of girls are saved from sexual intercourse by the fact that the young men who approach them do so quite openly. They make their requests in the first moment meeting the girl in the street". (1)

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(1) In England, for instance, it is registered in the following official reports recently published:

(a) Plowden Report: Children and Their Primory Schools, H.M.O., 1967.

(b) Newson Report: Half Our Future, H.M.S.O., 1963.

(c) Robins Report: Higher Education, H.M.S.O. 1963.

The educational system of any given country is built on the basis of established cultural and historical tradition, but chiefly in accordance with class structure and the demands of its ruling class. In the Soviet Union society is composed of friendly classes. Socialism has created a unity of interests of the working class, the collective-farm peasantry and the intelligensia in the establishment of the new society. All educational institutions in the Soviet Union are run by the State, financed from the state budget and develop in accordance with the national economic plans. The respect and authority in which the teachers are held is an indication of the great role the school system plays in the life of the Soviet siciety. Teaching is one of the most honourable professions. many of today's statesmen, public figures and scholars are former teachers... Sociologists, psychologists and physiologists are working in conjuction with educators and teachers. The Academy of Pedogogical Sciences of the USSR and its wide network of scientific research institutions and scientific educational centres in each Union Republic are carrying out intensive research programmes in the field of education. Apart from the Academy of Pedagogical Sciences, which was established in 1943, the scientific research institutes of Pedagogics of the Union Republics and over 200 departments of pedagogics and psychology of the universities and educational institutes of the country conduct various research programmes on education, the psychology of learning and teaching.

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(1) **Newsom's Report, PP. 17—20.**

From the learning the alphabet, as previously noted, to the conquest of the outer space – this is the road travelled by the Soviet society in the field of education. When the Soviet power emerged triumphant, the vast majority of the adult population could not read or write. The progress which the Soviet Union has made in the sphere of education is extremely ipmressive. No other country in the world has achieved excellent results in the field of education in such a short period of time and under extremely difficult circumstances as the Soviet Union: the economic and cultural backwardness and extreme poverty inherited from the tsarit Russia which were futher aggravated by economic dislocation, which resulted from the First World War, foreign intervention, the civil war and the German Nazi invadors.

The principle on which the Soviet school system is based on a consistent and complete spirit of genuine democracy — equal opportunity to receive education at all levels and for all citizens. The unity and continuity of all stages of education in the USSR are the important features of the Soviet school system. There is a single, nation-wide system of elementary, secondery and university level of educational establishments. There are no dead-ends schools from which there is no advancement possible to the next higher stage of education. A pupil proceeds unhindered from infant schools to the university through different forms of secondary education. At the same time, the schools of all types provide for all pupils an equal and sufficently high level of education, for it is only possible to discover and fully develop the talents of youth, on such a broad general educational basis. Besides, in the higher grades of secondary school there are free-choice extra-curricular subjects which satisfy, as previously stressed, more fully the individual interests of the child in a given field of science, technology, art or particular skills. However, the compulsary subjects provide a sound education, even if the pupils do not attend the free-choice classes.

The family, the school, the extra - curricular establishments and the general social climate instill in children a spirit of collectivism, friendship, comradship, and mutual aid based on scientific ideology and socialist humanism, which differ in principle from the Western ideology based on expliotation and rugged individulism. Socialist collectivism is not a barrier to satisfying the personal needs of the individual, or to developing his creativity, as alleged opponent ideologists of Soviet pedagogics. On the contrary, within the socialist collective each individual finds untold possibilities for personal development, while a conscious sense of discipline and the cultural wealth of each individual member of the collective are a guarantee for his lasting vitality. In the Soviet Union labour is not only a duty but also a matter of honour for each citizen. A creative attitude towards work is instilled in children from the first grade. Various types of labour training in schools and enterprises are complemented by socially useful work which serves as the young person's first introduction to his duties as a citizen.

In the Soviet Union concern for a child's well-being begins long before his birth. Maternity care is free of charge and all women receive a fully - paid leave of 112 working days. In cases where there are twin births or difficult labour the maternity leave is extended accordingly. In the course of one entire year she will retain the right to return to her former job, with the year included in her tenure. There is constant medical supervision and care for the newborn. A visiting nurse from the children's clinic supervises each infant from the time it is born until it is six months of age. A pedriatrisian follows the child development and health. There are milk kitchens affiliated with every infant consultation centre, where mothers receive special formulae milk and other baby food for their infants. The Soviet family is, of course, an organic part of the Soviet society". and every attemp it makes to build up its own experience independently of the moral demands of society is bound to result in a disproportion, dicordant as an alarm bell" writes Makarenko.⁽¹⁾ "Our parents are not without authority either, but this authority is only the reflection of social authority. In our country the duty of a father toward his children is a particular form of his duty towards society. It is as if our society says to parents: you have joined together in a good will and love That is your own personal affair... But in this happy

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(1) **Makarenko, A.S. A Book for Parents, Moscow, Foreign Languages Publishing House, 1954, PP. 25—26.**

process you have given birth to new people. A time will come when these people cease to be a joy only to you and become independent members of society. It is not all a matter of indifference to society what kind of people they will be. In handing over to you a certain measure of social authority, the Soviet state demands from you correct up-bringing of the future citizens. "Nor is the family the sole or even the principal deligate of the society for up- bringing children. Such primary responsibility is vested still in another social structure: the children's collective: a group of children united in a common, goal-oriented activity and the communul organization of this activity. From the beginning the stress is placed on teaching children to share and to engage in joint activity.

In school, as already mentioned, are also held extra-curricular works. There are, in addition, extended day groups for children of the lower grades and intermediate grades whose parents are away at work and who would otherwise be left to their own devices. These children have a hot meal at school after the day's lessons are over. The youngesters go to bed for a nap. Each group has its own teacher. These extended day groups can be created in any school. However, there is a special network of schools with a regular extended day. In order to insure universal education for children residing in settlements located far from schools, they are provided with free trunsportation and free or statesupport school lunch programmes. In regions with harsh climate, as in the Far North, in mountainous regions, or in areas where nomadic cattle-breeding serves as the main occupation of the population, the majority of children attend boarding- schools that are completely state-supported.

The history of psychology, like that of other sciences, is the history of the conflict between the two conflicting philosophies: materialism and idealism. All progressive thinkers were adherents of the materialist theory, while idealism always provided a foundation of reactionary views. idealism not only hampered progress of sciences, but was an obstacle to their very formation. Idealism treats the psychic factor as something autonomous and independent of matter; i.e., it is not a special property of matter, nor is it a function – a product – of the brain. Materialism, on the other hand, starts from the assumption that the psychic factor has no independent existence, but is only a property of matter and is formed in the long processs of its development. Since idealsim accepted the psychic factor as independent, it attempted to explain the entire mental life from outside of life itself, from the laws of psyche. In doing this, it ignored the most important fact which is offered by our knowledge of dependence of experience on the nervous system and the outside world: namely, that consciousness is itself, only a property of matter, a product of the brain, and that it develops as a result of the action of an objective reality which is outside us and independent of us. Idealism could not and would not understand that consciousness is merely a reflection, an image in us of the real world. It could or would not understand that the social relations are the most important among factors of objective reality that influence us, and that these relations are determined by the material living conditions of society. It also ignored the fact that these relations are shaped quite differently in different historical eras, depending in each case on the material living conditions of the society in question.

No, could mechanistic materialism offors an adequate explanation of true nature of the human psychological processes. This materialism, which is also metaphysical, has the characteristic trait of trying to explain the psychic processes by purely physiological or even physical and chemical processes. The so-called vulgar materialism was particularly far removed from positive and scientific understanding of the nature of the psychological processes. This equally true of American Behaviourism.

Only scientific materialism has a correct conception of the nature of mental life. It proved that mental life is a special property of highly organized matter, which consists in representing the material world. It alone afford the prove of the social conditioning of human consciousness and of its dependence on social relations which are, in their turn, determined by the material living conditions of each society. It alone emphasized, the historical nature of consciousness and revealed the class character of consciousness in a class society.

The reflex activity of the cortex is activity that is at once nervous — physiological — and psychic — mental —, in so far as one and the same activity is regarded from different standpoints. Therefore, the task of studying it is towfold: it must be studied as nervous activity governed by the physiological laws of neurodynamics: the processes of stimulation and inhibition, the irradiation, concentration and mutual induction of these processes. Second, it must be studied as psychic activity: The processes of sensation, perception and observation, memory, thinking, attention. Since psychic phenomena obey the physiological laws of higher nervous activity — the laws of neurodynamics —, they appear as the effect of the operation of the physiological laws.

Similarly those physiological and biological phenomena which obey the laws of chemistry appear as effects of operation of chemical laws. But physiological processes present a new, unique form of manifestation of chemical laws, and it is precisely this new specific form of manifestation of chemical laws, and it is precisely this new specific form of manifestation that is covered by the laws of physiology. In the same way, the physiological laws of neurodynamic find in psychic phenomena a new, unique form of manifestation which is expressed in the laws of psychology. In other words, psychic phenomena remain psychic phenomena, even though they appear as a form of manifestation of physiological laws; just as physiological phenomena remain physiological, though as an outcome of biochemical investigation they also appear as a form of manifestation of the laws of chemistry. Such, in general, is the interrelationship of the laws governing the lower and the higher forms of movement of matter, the relationship between lower and higher regions of scientific investigation. The fact that the more general laws governing the lower regions spread to the more specialized regions does not exclude the necessity of discovering the specific laws of these higher regions. The discovery of the biochemical nature of physiological phenomena, for instance, has resulted, not in the disappearance of these phenomena as specific phenomena, but in a deepening of our knowledge of them: with advances in the biochemistry of digestion our knowledge of this process becomes more profound; but though it may appear as the specific effect of chemical reactions, it remains a specific form of manifestation of these reactions — a process of digestion characteristic of living beings, and not a process of chemical elements.

We reject the assumption of directly inborn abilities. Only certain anatomical and physilogical characteristics of the organism, and especially of the nervous system, can be inborn in this sense. Abilities are always the product of development which takes place under certain definite social conditions: under certain quite concrete forms of human activity and in the course of a long process of upbringing and education. The peculiarities of the nervous system are always explicable in several different ways. Given the same starting conditions, the result of the development, as expressed in the abilities achieved, will be quite different corresponding to the differing conditions and forms of education and upbringing.

We also reject the quantitative measurement of abilities and, in particular, the method of tests which is so widely applied by the Western psychologists. We rejects this method because it is founded on a fatalistic theory of aptitudes which considers human abilities predetermined through heredity and unchangeable by environment. In this way, it denies the existing rich possibilities of development. This kind of theory assumes that it is possible, by measuring abilities at a certain time, to determine the suitability of individuals for future forms of activity. The tests are given a prognostic value which they actually do not possess. It cannot be determined without any further ado, from the way in which abilities express themselves in the future. The possibility of their development is in any case, extraordinarily great and it must be, moreover, remembered that abilities developed during and with the activities of the individual. They are, in essence, the result of the activity for which they are required and not the assumption or condition of the successful execution of such an activity. When an activity is executed, the abilities required for it develop in the individual.

Intelligence tests have neither a prognostic nor a diagnostic value. They are not even capable of giving a true characterization of the abilities that happen to be actually present at the moment of testing. Why do they fail to do so? The successful perforcemance of an activity, the solution of a problem, do not depend on abilities alone. They also depend on the underlying motivation, on what drives us towards the solution of the problem. Intelligence tests do not take into account the motives of human menl actions. However, rejection of intelligence tests does not mean that we do not think that it is necessary to investigate the abilities of pupils. But a correct investigation of abilities is possible only if the pupil's activities are performed under his ordinary conditions of life, and when his abilities are not investigated statistically. Such an investigation can be carried out by the teacher himself. He can investigate the pupil in all the forms of his activity and under the most varied conditions and he can follow the change and development of his abilities. In other words, mental abilities must not be studied in the abstract, but in connection with concrete activities of the pupil.

Abilities manifest themselves in activity and they can be judged only by their results. Inequality of abilities among individuals — or individual differences — may be intrepreted in two ways: either that some people are capable of a certain form of activity, while others are not; or that both are capable of this activity but in varying degrees. One view of abilities is that they are a gift of nature — of biology: heredity —.

This view cannot be right, however, because it ignores the role of the social environment and regards man merely as a biological, natural being and not a social being also. Moreover, even the biological aspect of the nature of man is not considered in its evolutionary perspective but rather statistically and metaphysically. Nevertheless, the opposite view completely denies the role of nature cannot be regarded as correct either, because it leaves unexplained the fact that even in the same conditions individual differences in ability may be extremely significant. Natural gifts are only conditions for the development of abilities; their actual development takes place in the course of the life of the individual under the influence of upbringing, training, education and other social factors.

The scientific educational psychology takes its departure from the assumption that the psychic activity of human being is in origin and function a reflex activity of the cerebral cortex. Knowledge, intellectual accomplishments and skills are all systems of conditional reflexes formed under the influence of external factors. The physiological theory originated by Pavlov notes that the higher nervous activity proceeds in the form of two contrary processes: excitation and inhibition which prossess the properties of irradiation and concentration. When identical stimuli are acting on the cerebral cortex at the time, protective inhibition sets in, with the result that reflexes already developed become diminished, and the formation of new reflexes becomes difficult. This often happens when pupils are kept busy day after day only with the formal mental work in the classroom. They quickly tire, become inattentive and start to lose the ability for understanding and assimilating the subject-matter. This does not happen if different types of activity — extra — curricular work — are intelligently alternate. Extra-curricular activity causes excitation of different parts of cerebral cortex from those affected by study and, as a result, those parts of the cortex which are used to master school subjects are inhibited, and consequently rested. When the pupil is engaged in school mental work, those parts of the cortex used to bring about mental processes are inhibited while the parts used in activity of learning arise at a condition of optimum excitation, thus ensuring a high degree of efficiency in both types of work. Moreover, physical work leads to the formation of new nervous connections and to the training of accomplishments and skills useful in production. Knowledge acquired in the class is applied in work and in this process this knowledge is extended and deepened. In working, school children often feel the need for new knowledge which essential to the fulfilment of some techanical task. This heightens their interest in learning and stimulates them to seek for themselves the answers of questions that arise.

Psychology, and that of education in particular, is one of the human sciences. It is essential to discover the laws governing the psychic activity that goes on in man's brain. Since psychic activity which goes on in the brain, it is subject to all laws of neurodynamics. Without knowing these laws it is impossible to fully explain psychic phenomena. Therefore, psychic investigation cannot be regarded as opposed to and isolated from the physiological study of neurodynamics. On the other hand, some of those who attempt to deal with the question of regarding psychology as a social science usually complicate matters by postulating that natural sciences and social sciences are opposed, so excluding communication between them. Moreover, by using the terms "social sciences" they obscure the finer shades of difference between sciences dealing with society and those that deal with socially determined phenomena. It is to this latter group that the psychology of man and the other human sciences belong. The traditional anti-thesis between the natural and social - historical sciences, which presupposes an objective anti-thesis between nature and society, inevitably falls to the ground when the subject of man is approached, for man is both a product of nature and the subject of history. It is impossible therefore, to find a place for the human sciences in general, and psychology in particular, if the starting point is the anti-thesis between nature and society. Psychology, as one of those sciences dealing with the nature of man which is the product of history, has a special connection with sciences that deal with nature — primarily the physiology of higher nervous activity — and with socio-historical sciences.

The subject of study of psychology is psyche: man's mental or psychic activity. But this cannot, of course, be equated with the concept of the "subjective" since the subjective as such, taken by itself, cannot be the subject of any science. It is secondary and derivative, and cannot be studied or understood in isolation. It is the subject of psychology only in combination with the objective. The subject of the scientific materialist psychology is man's psyche, understood as the function of that particular complex fragment of matter called human brain which reflects objective reality existing independent of consciousness. The mind of man — his psyche — must be studied in its dependent on the objective reality or conditions of existence, and the objective activity of which human life is composed. This is the only approach which can lead to a scientific explanation of the phenomena of man's inner subjective life. Psychic activity is higher nervous activity. Psychic processes are inseparable from cerebral processes. There can not be a psychic process as an independent process, one that is other in relation to the cerebral processes. A psychic process, once recognized as a product and function of the brain, annot be opposed to cerebral processes as purely subjective, i.e. purely psychic, and only occurring in parallel with the cerebral processes. It follows that the psychologists, in explaning any psychic process, must rely on scientific principles of higher nervous activity discovered by Pavlov and now being elaborated. Otherwise an exhaustive materialistic explanation of psychic processes is impossible. Psychic process is, at the same time, the reflectory activity of the brain, that is, our sensations, perception, conceptions and thought are images of the material world. Psychic processes, then, are more or less exact copies or imitations of the objective reality. It follows that the psychic cannot be reduced to the physiological; a physiological description of a process of perception or thinking does not include the content of the images and thoughts, and is not, therefore, exhaustive. In explaning psychic processes the psychologist must, therefore, pay heed attention to the reality they reflect. Moreover, psychic activity, like all other forms of living activity, is determined by the conditions of organism's existence. The human psychic is primarily and decisively determined by the social conditions of existence. Man's life, his social being, is always, reflected in certain aspects of activity.

Since psychic phenomena obey the physiological laws of higher nervous activity – the laws of neurodynamics – they appear as the effect of the operation of physiological laws. Similarly those physiological phenomena which obey the laws of chemistry appear as effects of the operation of chemical laws. But physiological processes are a new, unique form of manifestation that is converted by the laws of physiology In the same way, the physiological laws of neurodynamics find in psychic phenomena a new, unique form of manifestation which expressed in the laws of psychology. In other words, psychic phenomena remains psychic, even though they appear as a form of manifestation of physiological laws; just as physiological phenomena remain physiological, though as an outcome of biochemical investigation they also appear as a form of manifestation of the laws of chemistry. Such, in general, is the interrelaship of the laws governing the lower and higher forms of movenment of matter, the relationship between the lower and the higher regions of scientific investigation. The fact that the more general laws governing the more specialized regions does not exclude the necessity of discovering the specific laws of these higher regions. The discovery of the biochemical nature of physiological phenomena has resulted, not in dis-appearance of these as specific phenomena, but in a deepening of our knowledge of them. With advances in the bio-chemistry of digestion, for example, our knowledge of this process becomes more profound; but though it may appear as the specific effect of chemical reactions it remains a specific form of manifestation of these reactions'a process of digestion characteristic of living beings, and not a process of reaction of chemical elements, as already mentioned.

It is obvious, in the first place, that to represent the psychic and the physiological as two coordinated sides of a single process is incorrect. This formulation conceals the hierarchy of the primary and the derivetive: of the basis and the form of its manifestation, which expresses the essence of the relationship between the physiological and psychological characteristics; it mistakenly represents the two as related on equal terms, as coordinated, parallel. The mistake is that the various sides are indicated but not the interrelationship of these sides. Another proposition, which is sometimes opposed to that cited, is also invalid. According to this, physiological and psychological characterizations are consecutive components of psychology's characterization of these phenomena: physological being limited to a partial – physiological – characterization of these phenomena. This proposition expresses the theoretical conception of the old physiological psychology at once mechanist and idealist from the standpoint of philosophy. To give physiological and psychological descriptions separately and consecutively, or to include the first in the second, means that the physiological charaterization of phenomena loses its effectiveness; insofar as in this framework, psychic phenomena do not appear in the specific role as that new, original form of manifestation of psychological laws, which finds expression in the laws of psychology. Therefore, when an attempt is made to discover specific psychological laws, from this initial standpoint, a false antithesis between the psychological and physiological laws arises. This antithesis, and the isolation of one set of laws from the other is simply an expression of the falsity of the external, consecutive combination of physiological and the psychological in the original propositions. Another view, very generally held but no less erroneous is that the laws of neurodynamics have to do with the material basis of psychic phenomena: while the psychological laws relate to the pychic phenomena which form a superstructure on this material, physiological basis. This formulation is particularly misleading because, by describing the laws of higher nervious activity as the basis of psychology it seems to approach a genuine understanding of the relationship between the physiological laws and psychology. But, in fact, the real tendency, the inner sense, of this formulation is towards dualism. It establishes, in a vertical direction, so to speak — from the physiological basis to the psychic pheno — mena which are constructed on the top of it —, the same external, consecutive picture as was presented by the preceding proposition in a horizonal direction. According to this view the laws governing higher nervous activity have no bearing on psychic phenomena, but relate only to their physiological basis. Psychic phenomena, seen in this light, do not appear as a form of manifestation of neurodynamic laws; the links have been broken. This, once more, means a restoration of the old schema which is both mechanistic and idealist. The whole content of Pavlov's teaching on higher nervous activity, the course of the development of science, refutes this conception.

The most important point of the theory of mental development of the child is to know by what factors his psychic development is determined. The main principle is to know that decisive role in the psychic development of the human being is played by the conditions of his life, which is always the life of society and it is not determined by natural biological inclinations of man, but by the historical conditions of the material life of society. However, it is not by mere fact of their existence that the conditions of life may determine the psychic development. Man, as already mentioned, is not a passive object determined by the surrounding world. He can create and does create the conditions of life. The conditions of life existing at a given moment, as well as the natural differences in the nervous system, do not predetermine the psychic development which depends upon what is done, the purpose, the character, and the structure of the activity. Hence, each individual develops in his own way, but ruled by the laws of society. A child raised in a society that emphasizes cooperration, sharing and friendship would display different character qualities from those shown by one who sees only selfishness, hate and hostility.

In school education, a good teacher can achieve excellent results with a child who does not appear to have outstanding abilities, but who is simply a normal child physically and intellectually. Many centries of experience, both social and educational, prove that the psychological functions have vast polentialities. They are created by the conditions and influencod, above all, of the social nature, to which they are exposed. The impact of social invironment with all its interconnecting features on the moulding of the individual is much greater than we sometimes suspect. However, there is another point of view. It is associated with the names of the leading Western psychological authorities. I for one cannot accept it. It is an elite theory of upbringing and education. It is based on assumed vast individual differences in native mental abilities, and that the potentialrties of an individual can be assumed at a very early age. In Western countries that point of view has gained currency that school children should be streamed into different groups depending on their native intelligence and that each group should be taught accordingly. I am fully convinced that the educationists and psychologists of this school do not have reliable criteria for gauging the intellectual level of the primary school child. How can one determine the fate of a young-ster without knowing accurately how he will develop in the immediate future? Instead of revealing the level of his abilities, the intelligence tests show the child general development level. If his family's material and cultural standards are not high, the child may, at a given moment, be developing slower than another of the same age from a more prosperous family. But does this indicate his real abilities? Of course, not.

What would happen if the classroom becomes a model of the situation in a laboratory? By setting up "problem situation", for example. By organizing teaching in such a way that pupils independently repeat already made discoveries under the guidance, of curse, of a teacher who always helps them get out of blind alleys. Some advanced Soviet teachers teach the principles of inventions and discoveries. From analysis of the paths that have led to already known inventions and dis-coveries, it has been possible to formulate a series of recommendations on teaching method that encourages habits of creativity and concentration. Newton, we are told, wanted to boil an egg. Taking a watch he noted the time he started the cooking. After a while he discovered that he was holding the egg in his hand and was cooking the watch. But, when the scientist was once asked how he had managed to discover the law of gravitation, he said: "Because kept thinking about it all the time." Georges Cuvier (1760—1832), a great French naturalist, defined "genius" on the basis of Newton's foregoing words, as incessant attention. Must we, then, agree with Buffon's thesis that creativity is nothing else than a long patient concentration on a particular problem... Indeed, a tenacious continuity of concentrated attention is the essence of the creative process. It is an established fact in psychology that an organized intellectual activity possesses always some degree of directivity and selectivity. Of the many stimuli which reach us, we resopnd to only those few which are particularly strong or which appeared partcularly important and correspond to our interests, intentions or immediate tasks. From the large nember of possible events we choose only those which enable us to reach our immediat goal or to perform a necessary act; and from the large number of traces or their connections stored in our memory, we also select only those few which correspond to our immediat task and enable us to perform some necessary intellectual operations.

Any organized mental activity, to emphasize again, possesses some degree of directivity and selectivity. Of the many stimuli which reach us, we respond only to those few which are particulary strong or which appear particularly important and correspond to our interests, intentions or immediate tasks, as previously stressed. And from the large number of possible movements we choose only those which enable us to reach our immediate goal or perform a necessary act; and from the large number of traces or their connections stored in our memory, we also select only those few which correspond to our immediate task and enable us to perform some necessary intellectual operations. The directivity and selectivity of mental processes, the basis on which they are organized, is usually termed attention in psychology. By this term we imply the factor responsible for picking out the essential elements for mental activity, or the process which keeps a close watch on the precise and organized course of mental activity. It would be a mistake to imagine that the attention of the child can be attracted only by powerful and novel stimuli, or by stimuli connected with immediate demands. From the beginning the child lives in an environment of adults. When his mother names an object in the environment and points to it with her finger the child's attention is attracted to that object, so that it starts to stand out from the rest regardless whether it gives rise to a strong, novel or vitally important stimulus. This direction of the child's attention through social communication, words or gestures, marks a fundamentally important stage in the development of this new from of the social organization of attention. Later, it gives rise to the type of organization of attention with most complex structure, voluntary attention. Of course, this higher form of attention does not become possible immediately. Long studies have shown that the reverse is the case; the formation of voluntary attention has a long and dramatic history, and the child acquires an efficient and stable, socially organized attention only shortly after he is due to start school. The futher course of formation of this higher type of initial, voluntary attention, which by school age has become established as a stable form of selective behaviour, subordinated not only to the subtle speech of an adult, but also to the child's own internal speech.

Presentation of a special — visual, acoustic, tactile-stimulus evokes an electrical response, that is, the evoked potential in the corresponding regions of the cortex — occipital, temporal and central. A particularly important feature of our purpose here is that the structure of these changes varies substantially, depending on the intensity of the stimulus and on the subject's activity. A comparison can be made between the way in which the evoked potential changes during the distraction of attention by a irrelevant stimulus, and how it is increased when attention to the relevant stimulus is strengthened. Tests of the first type were included in the classical investigation of Peon(1) who showed that potentials evoked by an acaustic stimulus in a cat are strongly inhibited on presentation of the sight or smell of a mouse. "Tests of the second have been carried out mainly on man; potentials obtained in response to usual presentation of sensory stimuli were compared with evoked potentials obtained during active expectency of these stimuli-after a warning instruction –, or when the analysis of these stimuli was completed by the presentation of instruction: such as "Count the number of stimuli" or distinguish between

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(1) Hernandez — Peon, "Modification of Ellectric Activity in Cochlear Musculs during Attention in Unanesthetized Cat" in Science, Vol. 123, 1956, PP. 331—333.

changes in the one or intensity of the stimulus and and so on. The results obtained... showed that attraction of attention by active expectency or complication of the task leads to an appreciable increase in amplitude of the evoked potentials.(2) The cerebral mechanisms of the complex form of attention are the frontal lobes which play the most important role in raising the level of vigilance of the subject when performing a task. Thus, the frontal lobes participate decisively in the higher form of attention.

It is well-known fact that Terman of Stanford University and his coworkers have investigated, in their menumental parallel study in two directions for about two decades, both the life histories of 301 eminent personalities and 1,300 intelligetly superior school children. On the one hand, the intellectual lives of the outstanding persons have been tracted backward to childhood and, on the other hand, the development of the highly intelligent children has been followed in the forward direction from childhood to early maturity. In no less than twenty of the 100 cases whose childhood is best known, among the 301 great men studied by Terman and Cox, there was unsuccesful pressure to turn the concentrated attention of the subject into another field than that in which the eminence was achieved. The destiny that half of these had to escape was the legitimate procedure. Bolzac's parents, for instance, tried vainly for five years to convince him to be a lawyer. When Victor Hugo was nineteen his father offered him an allowance if he would retinquish literature for a more substantial profession, but he preferred to live in garret and write. Coleredge's father tried without success to have his son to be a parson. The story of Darwin is well-known and previously detailed. His attention was concentrated, on observation of nature from his early childhood and was taken away early by his father and sent to Edinbrugh to study medicine without success. After two years he stopped schooling altogether. His father decided on his son's behalf that he should join the ranks of clergy and sent him to Trinity College(3) Cambridge but, as a keen young naturalist, Darwin's real passion and intellect were for but chasing wild fowls. As an undergraduate in Cambridge, even the help of the private tutor could not bring him an understanding the most elementary principles of algebra. This had happened because his mind was immersed in something else. He did a minimum of work at Cambridge and spent most of his time shooting and observing natural phenonena. At the age of 21, he was, just a stupid, inspite of that or because of it, as aleardy noted. Newton at 15 had left school and sticked to an uncle who had attended to Cambridge, and Faraday left school at thirteen, and at fifteen was apprenticed to a bookbinder. It was the passionately reading of an article on electricity in an encyclopedia given him to bind that first stimulated his already flowering interest in science. The life history of Pasteur, Einstein is well-known and already mentioned and need not be related here again.(4)

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(2) Luria, A.R., working Brain, London, Penguine, 1973, P. 267.

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(3) Barlow, N., Editor, The Autobiography of Charles Darwin, London, Collins, 1958, P., 44.

(4) See the following succinct biographies:

(a) Cuny, H., Pasteur: The Man and His teories, N.Y., Fawcett, 1967.

(b) Cuny, H., Einstein: The Man and His theories, N.Y., Fawcett, 1966.

In many cases, creativity is cultivated in early childhood by giving the child encouragement, intentive direction, continuing opportunity as he advances, a congruent stimulating social life and cumulation success experiences. At any age, development of creativity is initiated by a powerful immediate intellectual climate, expert guidance, frequent progressive facilitation, and consistant friendly atmosphere. Important advantages would seem to occur from having all those factors begin operating earlier. Also, and this is very important, the child should be in the grip of a strong interest — as a hobby — regarding a particular branch of human learning: a single — mindedly absorbed in it to an extent less common later, when problems of social status, economic responsibilities — and the other sex according to Freud—, may distract. The life of Mozart is a vivid example in this respect. He lived from early childhood in a world of musicians, listened to and watched by one another, cooperated, competed, raised levels of aspiration, and were keen in criticism and encourogement. His father was a musician, and his older sister was his companion in music. Family and friends admired and encouraged the tiny boy. From the age of three, he was taught, directed and managed, in his career by his father, who saught practically from the beginning, to make his son a remarkable musician. That it a celebrated example. A recent one, no less celebrated, is that presented by Deakin in a little book named: The Children on the Hill.(5)

Cattell and Buncher have recently surveyed the lives of a large number of eminent scientists and submitted the results of their investigation to the New York Academy of Sciences. They reached this conclusion: "The typical scientist appeared introverted. The predominant... tendency to introversion obesrved particularly among physical scientists — such as Lord Cavendish, Dalton, Priestly, Lavoisier, Scheele, Avogadro and J.J. Thomson — is logically not surprising in view of the nature of fundamental research". (6) This tendecy is easily explained by the fact that the attention of such brilliant scientists as entirely concentrated on their own

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(5) London, Quartest Books, 1973, Especially PP. 34—70.

Another American researcher, Roe, reached a similar conclusions in her "A Psychologist Examines Sixty-Four Eminent Scientists". (7) She selected the most outstanding scientists in the United States as subjects of her research and found that each one of them did a great deal of reading in his field and from his early life, and tended to be lonely, different and aloof from his classmates; he had only a moderate interest in girls, and did not begin dating them until college. What stimulated each one of them to scientific research was a college project in which he had occasion to do some independent work. Once he dis-covered the pleasure of this kind of work, he never turned back, but worked hard and devotedly in his laboratory, often seven days a week, and considered his work as his life and recreation. Movies bored him and he avoided social affairs and political activity, and religion played no part in his life and thinking. "The one thing that all of these sixty-four scientists have in common is their driving observation in their work. They have worked long hours for many years, frequently with no vacation to speak of, because they would rather be doing their work than anything else". (1)

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(6) Cattell, R.B. and Buncher, H.T., Creativity and Personality, quoted By vernon, P.T., editor, Creativity, London, Penguin, 1973, PP. 212—213.

(7) Ibid, PP. 312—326.

Mackinnon, another American invesigator, describes the results of his study: "The Personality Correlates of Creativity: A Study of American Architechers" in these words: Almost without exception one or both of the parents were of artistic temperament and considerable skill... Often it was the mother who in the architect's early years fostered his artistic potentialities... In school and college the architects were terribly good students, but in general not outstanding if one may judge from their academic grades... In work and courses which caught their interest, they could turn in an "A" performance, but in courses that failed to strike their imagination, they were quite willing to do no work at all". (2) This means that the most obvious characteristic of creative thinker, scientist or otherwise, is his dedication to his work almost from his early life. Roe, as previously mentioned, noted that her scientists constantly worked so hard that all other aspects of their lives were bound to suffer. Although some of them have cut down somewhat their hours of work as they have grown older, it is still the common pattern for them to work even on Sundays, holidays, as they always have, and are happy when they are working.

It appears that the primary factors in supreme scientific achievements are moral qualities. High intellectual ability is, of course, essential, but, even more important is determination, and the will to dis-covery. It is a striking fact that all creative scientists, as soon as they had found their vocation,

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(1) Ibid., P. 51.

(2) Ibid., P. 51.

(1) Ibid, PP. 312—326.

pursued research with extraordinary concentration. Copernicus worked steadily at his great book: "The Revolution of the Celestial Spheres" among the numerous duties of a busy life, for thirty — six years and received an advance copy only on his deathbed. He spent no less than ten years in Italy of Michelangelo and the Borgias, absorbing the learning of the Renaissance before returning to the Baltic to work out its scientific significance. Galileo smuggled the greatest of his books out of Italy and published it abroad, when he was sixty — eight and already for many years under the surveillance of the Inquisition. Nothing could prevent him, not persecution, not old age, nor approaching blindness. Newton wrote his Mathematical Principles of Natural Philosophy in fifteen month by an astounding effort of concentration, when he was already connected with Whig polities, and to take an important part in the rebelion against James II. Einstein started earning his living as an engeneering clerk in the Office at Berne. He discovered the theory of Relativity during his spare time at home and in the office. He used to do his research on bits of paper, and when any one came into his room at the office, he slipped it into a drawer. It was almost like a schoolboy doing homework under the desk during a lesson. He never met a first rate physicist until he had dis-covered the theory of Relativity.

One thing all creative scientists have in common is the determination to do scientific research whatever the obstacles. The first factor in their achievement, was their character: The will not be defeated. The second factor they all show is the imagination to conceive a great idea. When they had got the idea, nothing could stop them from proving it was true. Creative scientists are indeed unusually hard working to the extent of appearing almost obsessed with their work. The common characteristic of all of them is to have without exception an intense devotion to their work; there is never a question of putting in so many hours a day, a week, or a year. Instead, they work nights, weekends, holidays, all the times. In fact, one wonders how they ever find time to be with their families; their work itself gives them the greatest satisfaction in life. Those who registered the biography of the mathematical genius Carl Fredrich Gauss said that "to him, mathematics was all. It was just as necessary for him to solve problems as to breathe, eat and drink... He could spend months on the most routine, monotonous job. He could compile tables for weeks and with the greatest of pleasure, he could do work that in this enlightened age is handed by electronic calculators". (1)

Kekule's father, who was a close friend of a number of famous archilects, dicided that his son should study architecture. Accordingly, the son entered the University and followed with commendable diligence under Ritgen's guidance descriptive geometry. But Liebig's lectures in chemistry tempted him to change subjects. Moreover, his years of apprenticeship took him to Paris, when he was able to listen to what he believed were the last lectures of the famous Dumas; and by accident he met Gerhardt, who was preparing the complete manuscript of his famous textbook for the printer. A stay of a year and a half at a lonely Swiss castle — as a chemical assistant to Baron von Planta – gave him leisure to assimilate independently the insights he had gained from the still unpublished manuscript. His travel years took him further to London. While Paris gave him the opportunity to become acquainted with unpublished views of Gerhardt, in London he had the good fortune to become a good friend and to familiarize him with the mode of thought of this investigator. Originally a student of Liebig, he had become a student of Dumas, Gerhardt and Williamson. These seem to be the factors why his chemical ideas which were in the air found suitable soil in his mind.

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(1) Sligma, V., In Search for Beauty, Moscow, Mir, 1970, P. 233.

Newton, to stress once more, displayed striking powers of concentration. He became completely absorbed in his work and oblivious of his surroundnings. Newton said that he differed from others, the difference lay in his capacity to pay his undivided attention to his scientific problems. He would almost go into a trance for many hours at a time when pondering over something. When he was asked how he discovered the laws of nature, he replied that he had a greater power of concentration. He could hold a problem in his mind with more intensity, until all the parts fell into place, and the solution appeared to him. Gaethe ascribed his first interest in drama to the gift of a set of puppets when he was seven. His biographer, Brown, described the struggle and friction between father and son concerning his choice of career. His father was determined from the beginning that his son should become a lawyer, and the boy's desire to be a writer was ignored. The boy wanted to go to the University of Gottingen, but his father overrode his desires and entered him for the Univ., of Leibzig. The boy said later that he left his home at Frankfurt with joy as intense as that of the prisoner who has broken through his cell window and finds himself a free man. He left with delibrate intention of following his own inclination, to study literature. He told his professor about his intention, and the latter tried to discourage the boy who refused to attend the lectures, and his attendance became a joke. Faraday was brought up in a home of great poverty, and at the age of thirteen was put to work as an errand boy to a bookseller, as previously mentioned. He was promoted to be an apprentice bookbinder — and this gave him access to books, which he read avidly in his spare time. He particularly enjoyed reading books on electricity. He was allowed to attend a series of lectures on science, at a shilling a time, paid by his employer and brother. He expected to be a bookbinder for the rest of his life. The turning point in his career came when he copied out Sir Hamphry Davy's lectures and bound them, sending them to Sir Humphry and asking for a job in the laboratory. He was given a job washing bottles, polishing desks, cleaning the inkwell and sweeping the floor. He helped Sir Humphry, and began to work with him. Beethoven, regular schooling ceased when he was eleven, and he was practicing music from the age of five. His life as a serious musician began when he was thirteen, and at seventeen he went to Viena, where Mozart asked him to improvise for him, and gave him some lessons free of charge. Poincare first became seriously interested in mathematics when he was fifteen. He was never disturbed by others talking while he worked; he was completely absorbed that he often forgot his meals. It is interesting to note that when he was acknowledge as the foremost mathematician and leading man of science in his time, he submitted to the Benet intelligence test, and made such a disgraceful showing that he had been judged as a child instead of as the famous mathematician he was, he would have been rated as an imbecile. Marconi came into conflict with his father because of apparent wastefulness of anything else. Marconi's daughter in her biography tells how one incident precipitated a real crisis. The boy borrowed a book by Benjamin Franklin, and inspired thereby, was making some experiments of his own. The boy was seen to the edge of a stream with a series of dinner plates which he had arranged in contact with a piece of string. When they were all in place he passed a high voltage electric current through the string, sending the plates crushing on the stones. The spectators and his father thought that boy was crazy. From that time onwards his father systematically ruined the boy's apparatuses whenever he saw them. His mother did her best to help her son to conceal his apparatuses from his father. His daughter recorded that the boy was particularly liable to get into trouble at mealtime, where he was expected to join the coversation. He would be absorbed in his thought, and then suddenly talked about the subject of his thought-much to the annoyance of his father. At one stage his mother became anxious about him because of his extraordinary concentration on his work. She consulted a doctor as to whether he was going to damage his health, but he reassured her. She went out of her way to leave him in peace. The real turning point in his career came when, at twenty, he picked up a journal on electricity, containing an article by Hertz, which really fired his imagination. His father deliberately deprived him of money, and the boy had to sell his schoes to buy some metals, wire and batteries. He completed his apparatus, but the Italians turned it down. He therefore took it to England.

The life of Pavlov gives a celebrated example in devotion to scientific work. His student, coworker and colleague Horsley Gantt, describes so vividly Pavlov's scientific life in the the following words :(1)

"*One of Pavlov's most striking traits is his systematic regularity in all the details of his life. He goes to work and leaves with military punctuality, and it is extremely rare that he is a minute behind in arriving, or more than a few late in leaving... During the Revolution in 1917 it was very difficult to get to the laboratory at all, because besides other things, there was aften shooting and fighting on the streets. However, Pavlov was generally present, even though no body else was ... Formerly he came to work at nine O'clock and left at six, taking one-half hour for lunch; but having passed the three score years and ten, he has reduced the working day by two hours from 10 A.M. to 5 P.M. Before the Revolution he also spent holidays in the laboratory, even New Year and Christmas.* He has said that he never missed a day from September first to June first. On Sundays he remained only till 3 O'clock. From nine till ten or eleven in the evening he has tea... with his family... From this hour till about one or two O'clock he reads or writes". (1)

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(1) Gantt, W.H. in his "Introduction" to Pavlov's: Lectures on Conditioned Reflexes, London, Lawrence and Wishart, 1928, Vol. 1, P. 25. Italics not in origin.

In his letter to the youth Pavlov says "First *of all* — consistency... Right from the very beginning inculcate in yourself the habit of strict consistency in acquiring knowledge ... *Learn the ABC of science before you attempt to scale its peaks. never embark on what comes after without having mastered what goes before... Develop in your self restraint and patience... STUDY, compare, accumulate facts... Facts are the air of the scientist... But when studying, experimenting and observing, do your best to get beneath the skin of the facts... Search persistently for the laws governing them.*"

So far we have been concerned with the phenomenon of concentration in the field of scientific research. Now I shall introduce a lively picture of concentration in the domain of poetry which was depicted in 1946 by the famous American poet Stephen Spender.(1) The writing of poetry is an activity which makes certain demands of attention on the poet and which requires that he should have certain qualifications of ear, vision, imagination and memory. He should be able to think in images and have as great a mastery of language as a painter has over his palate. The problem of creative writing is essentially one of concentration and the supposed eccentricities of poets are usually due to mechanical habits or rituals developed in order to concentrate. Concentration, of course, for the purpose of writing poetry, is different from the kind of concentration required for working out a sum. It is a focusing of the attention in a special way, so that the poet is aware of all the implications and possible developments of his ideas, just as one might say that a plant was not concentrating on development mechanically in one direction, but in many directions, towards the wormth and light with its leaves, and towards the water with its roots, all at the same time. Schiller liked to have a smell of rotten apples, concealed beneath the lid of his desk, under his nose when was composing poetry. Walter de la Mare said that he must smoke when writing. Auden drinks endless cups of tea. Coffee is Spender's own addiction, besides smoking a great deal, which he hardly ever do except when he is writing. Spender notices also that as he attain a greater concentration, this tends to make him forget the taste of the cigarette in his mouth, and then he has a desire to smoke two or even three cigarettes at a time, in order that the sensation from the outside may penetrate through the wall of concentration which he has built round himself.

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(1) Spender, S. "The Making of a Poem" in Vernon, P.E., editor, Creativity, London, Penguin, 1970, PP. 61—76.

Of course, the rotten apples or cigarettes or tea have nothing to do with the quality of the work of Schiller, de la Mare or Audencn or Spender; they are a part of the concentration which has already been attained rather than the causes of its initiation. De la Mare once said that he thought the desire to smoke when writing poetry arose from a need, not of a stimulus, but to canalize a distracting leak of his attention away from his writing torwards the distraction which is always present in one's environment. Concentration may be disturbed by someone whistling in the street or the ticking of a clock. There is always a slight tendency of the brain of a clock. There is always a slight tendency of the brain to sabotage concentration by providing some discretion. If this need for distraction can be directed into one chanel-such as the oder of rotten apples or the taste of tobacco or tea-then other distractions outside oneself are put of competition.

Different poets concentrate in different ways. Spender makes a sharp distinction between two types of concentration :

one is immediate and complete, the other is plodding and only complete by stages. Some poets write immediately works which when they are written, scarcely need revision. Others write their poems by stages, feeling their way from rough draft to rough draft, until finally, after many revisions, they have produced a result which may seem to have very little connexion with their early sketches. These two opposite processes are vividly illustrated in two examples drawn from music. Mozart and Beethoven. Mozart thought out symphonies, quartets, even scences from operas, entirely in his head-often on a journey or perhaps while dealing with different problems — and then he transcribed them, in their completencess, on to paper. Beethoven wrote fragments of these in note books which he kept beside him, working on and developing them over, years. Often his first ideas were of a clumsiness makeing scholars marvel how he could, at the end, have developed from them such miraculous results.

It is of primary importance to any theory of mental — psychic — development to answer the question: what determines this development? Mental development is the development of the brain. This is a cardinal thesis of materialist — scientific — psychology. It goes without saying that there are inborn, individual differences in higher nervous activity. But these inborn differences do not predetermine psychic development in the absolute way. The individual's brain also functions under the influence of social surroundings, and human mentality, being reflection of objective reality, is also formed and developed under this same influence. Individual behaviour is not, therefore, the simple expression of natural endowment, independent of external influences. It has a psycho-physiological basis in the system of temporary connections formed as a result of the influence of the environment and the individual response; these are not inborn but acquired during the individual's life experience. Moreover, Pavlov researches have demonstrated the extreme flexibility of the nervous system in forming these connections, which constitute the basis of human psychic activity and are always strictly determined by objective conditions. It follows that conditons of life play the decisive part in man's psychic development. These conditions depend always on society and are determined, not by the individuals biological inclinations, but by the historically determined material life of the society in which he lives. However, the conditions of life do not determine psychic development automatically, of themselves, simply by virtue of their existence. Under the same conditions development may take place in different ways; this depends on the place these conditions occupy in the life and activities of the individual, the way in which his life unfolds in them, and what is his attitude toward them. Psychic development takes place in the course of interaction between human beings and objective reality. A man is not the passive object of the influences of his surroundings, but an active participant in them. Men create the conditions of their own lives, and the present of former conditions of a man's life do not absolutely determine his psychic development, any more than do the inborn differences of the nervous system. A change in the conditions of life entails a change in individual development. There is, therefore, great scope for man's psychic development if there is conscious and directed organization of his life and activities, i.e. of the necessary conditions for development are created. Similarly, there is great scope for influencing the child's psychic development through education, for education is primarily the organization of the child's life and activity, while his psychic development is not a spontaneous, internally conditioned process, taking place apart from educational influences; on the contrary, education plays a leading part in the child's development.

Higher nervous activity is the activity of the higher centres of the central nervous system of animals and man which ensures the normal and complex relations between the entire organism and the external environment. The term "higher nervous activity" was introduced by Pavlov, who considered it synonymous with the term "psychic activity" or mental life. According to Pavlov, the basis of higher nervous activity in higher animals and man is conditional reflexes formed in the higher centers of the central nervous system-in higher vertebrates and in man, predominantly in the cerebral cortex-in addition to complex unconditional reflexes (instincts, emotions), that is, those forms of cerebral activity that arise mainly in the subcortical nuclei.

Perfect adaptation of an organism to its environment depends on the formation and extinction of various conditional reflexes. Conditional reflexes permit the organism, on the basis of certain (often) indirect singnals functioning as conditional stimuli, to prepare in time for favourable events and avoid unfavourable ones. They also help the organism to broaden its perception of objects and events in the surrounding world and its scope of activity. Unconditional reflexes in higher nervou activity are not only the basis of all conditional reflexes but are also, particularly the complex ones, the concentrated expression of the reinforced experience inherited from the preceding generations, as manifestation of genetic memory. In the behaviour of invertebrates and lower vertebrates innate forms of nervous activity predominate over acquired forms; in the process of phylogenetic evolution acquired forms of nervous activity gradually achieve a preponderance and emerge as the dominant ones. Moreover, these forms themselves undergo substantial changes: the conditional reflexes become more complex and more perfected and their number is constantly increased.

According to Pavlov, the higher nervous activity of animals, even those at a high level of development-for example, dogs and monkeys-, is, on the whole a result of the complexity of diverse and heterogeneous conditional reflexes, of the first signalling system which is common both to man and to animals. Inspite of the gradual development of speech, the conditional reflexes of the first signalling system still continue to constitute the basic fund in the higher nervous activity of children in the first years of life and occupy a specific place in the higher nervous activity of humans at subsequent stages of growth. To this type of conditional-reflex activity, Pavlov attribute sensations, ideas, and impressions derived by man from the external environment, including the social environment, which are formed without the use of verbal i.e. words-singals. But in the case of man, along with the development of social forms of labour activity singals of a second order, symbols of those primary signals — in the form of words pronounced, heard and seen-appeared, development, and become highly perfected. This qualitatively new, higher and more perfects second signalling system of reality, also based on conditional-reflex mechanisms, is characteristic only of higher nervous activity of man, exists in close interaction with the first signalling system, and playing a leading role in his conscious life providing the basis of generalization and thought. While continually emphasizing the fundamental, qualitative differences between these two kinds of higher nervous activity, Pavlov at the same time also pointed to the organic connection between them, to the fact that the basic laws established in the working of the first signalling system must also govern the second signalling system. Of vital importance for higher nervous activity is the dynamic nature of the specialization and localization of functions in the cortex of the cerebral hemisperes, which plays an important role in the reliability of its activity. Of vital importance are also the intensity and mobility of the neural processes, which, according to Pavlov, determine the physiological basis of the type of nervous system and of the nature of nervous activity, shed light on sleep, dreams and hypnosis.

The study of higher nervous activity has great theoretical and practical significance. It broadens the biological basis of scientific materialism, confirms the correctness of the materialist theory of reflection and serves as a scientific weapon in the ideological struggle against manifestations of idealism. The study of higher nervous activity is one of the greatest achievements of contemporery science: it has opened up a new epoch in the development of physiology; it has great significance for medicine since experimental results have provided a point of departure for physiological analysis and pathogenetic treatment-for example, by means of sleep-of various diseases of the human central nervous system; in addition, it has great significance in the realms of psychology, education, cybernetics, bionics-mathematical biology-, the scientific organization of labour and in many other branches of man's practical activity.

Pavlov's views on the nature of intellectual processes, and particularily of understanding, may be summed up as follows: when the narvous connections in the active region of the cortex are coupled, this marks the birth of a happy thought. Understanding is the correct use, next time, of previously formed connections. Faulty understanding is unsuccessful use of these connections. Thinking develops and understanding occurs when associations grow and increase.

There are two other hypotheses which are very important in relation to the problem of thinking. Pavlov speaks, first, of understanding as the use of previous connections; and, second, of the deepening of thought as the growth and increase of associations. The reflection in the brain of connections of reality does not necessarily constitute understanding. Understnading occurs only when a neural connection is established between fresh cortical excitation and old associations. This means that the creative act of thinking cannot be understood without considering the rôle of previous connections. No creative thought can take place without the support of previous experience.

In the light of what has been said so far, it becomes possible to explain how a given stimulus evokes a fresh reaction which is psychologically equivalent to a creative act of thinking. The previous experience, reflected in the brain in the form of an old association, intervenes between the stimulus and the reaction yet at the same time links the stimulus with a reaction with which it has never previously been connected. The concepts of previous experience and of old associations, which make possible a materialist explanation of the process of thinking and understanding are becoming key concepts in the Soviet physiological research. Pavlov's views are also relevant to a consideration of levels of thinking and understanding. Previous experience means connections or systems of connections impressed upon the brain as a result of earlier social activity. There can obviously be differences in the number and variety of connections between new and old experience, and also in the range of previous experience. The very first association emerging between separate elements of new and old experience indicates the emergence of a creative thought. This connection is, from the outset, knowledge of different relationships existing in the external world; but the latter may be chance, superficial, external and may not reflect any frequently recurring material features. In the course of further activity, connections between new and old associations grow and increase, and their reflection becomes more full and exact. Not only do isolated associations appear, but also "a chain of associations, linking one association with another". (1) Then "it is said that thinking becomes more profound, more extensive". (2)

Some may get the idea that, although the working activity of people in a socialist collective is founded on the common interests of these people, it is only a purely outword necesity merely a source of obtaining the means of substance. But even if one takes a view of work as a necessity alone, one can still see that the atmosphere in socialist collective is much more favourable for it than the one prevailing in a capitalist enterprise. But this is far from being the only favourable side to the collective organization of socialist production. It is within the collective that work becomes unshackled by virtue of the very fact that one is working for one-self, that labour, apart from being merely a vital necessity, acquires an independent value for the individual and becomes a basic source and element of a full happy life. It is precisely this significance for a person which is inherent in the very substance of labour and which right from the very beginning was not only a means of satisfying elementary vital needs, but also the base upon which *homo sapiens* was formed. It is in the process of creative labour that man's abilities are developed.

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(1) Pavlov, I.P., Selected Works, Moscow, Foreign Languages Publishing house, 1955, P. 586.

(2) Ibid.,

Under capitalism as well the labour process does, in most cases, consist of work performed by a large body of people associated for this purpose under a single roof. In such a case do the employees of an enterprise form a collective? No, a collective in the exact meaning of the word is not merely an association of people. The members of a collective are bound by a community of interests and it is precisely this common interest which is lacking among those employed at a private enterprise, and the reason for this is the private owership of the enterprises. The workers of such enterprises may be said to form a collective in so much as they develop certain common interests, but these interests have nothing to do with the results of their work. For it is not they who benefit from these results but the proprietor.

It is a person's awareness of his work's social significance that is of utmost importance to the socialist citizen. As he begins to feel that his work is an integral element of one great creative cause it stimulates his creative activity. The importance of the collective for the individual lies, first and foremost, in the fact that it becomes a sphere of a person's creativity. The collective plays an important rôle in helping people to develop and realize their creative abilities. This primarily applies to creativity in science and technology in addition, of course, to creativity in arts and other fields of human activity. It is an important asset of the collective that it awakens an interest for scientific and technological creation and encourages a person to take part in this activity. This is clearly manifested in the case of the intelligensia which differs from all the other strata not only for the occupational characteristics. It is not an occupational but a social group which holds a specific position in the social system and has distinctive functions, a distinctive internal structure, and relationships with the main classes of society. These characteristics of the intelligensia are by no means permanent and invariable in every epoch. The intelligensia is an extremely dynamic, mobile social stratum. In the course of history the place and role of the intelligensia in the life of society change essentially. In class society, the ideological stratum of the ruling clases is the most active group in the sphere of intellectual culture, whereas its stratum of practical work it is active above all in the sphere of economic management. In the ancient and feudal societies, the link between what may be described as the ideologically and practically active strata of the ruling class appeared in direct and open form. Ideologists of the slave-owning societies belonged, as a rule, to the ruling class for their place in the class pattern of society. Under feudalism, the caste of the cleargy and monks — the main ideological forces in the Middle Ages — belonged to the class of the feudal landlords in the same way as princes, barons, and other members of nobility. The defence and ideological support for the feudal order appeared in this case as their direct function dictated by their own social status.

Under capitalism, the pattern of relationships between the bourgeoise and its ideologists is more complicated. Technically, members of the intellectual professions may not directly belong to the capitalist class but come from other strata of society. The domination of the bourgeoisie in the cultural, intellectual sphere is manifested, therefore, above all in employment of mental workers for pay as hired labour working for the capitalists. The bourgeoisie intelligensia is directly dependent on the capitalists economically, and is therefore compelled to serve them by word and by deed. The basic social function of the intelligensia within capitalism — and all other antagonistic social systems - is the production and propoganda of the ideology of the ruling class in various fields : philosophic, scientific, art, legal, ethical, and other doctrines and views conforming to the interests of the ruling class. The intelligensia is the main ideological force in the class society.

It is a trgidy for intelligensia in bourgeoisie society that, because of their connections with the ruling exploiting class and their affIliation with it through their cultural and ideological orientation. they lose their links with the people and become isolated from the life-giving source that can nourish and inspire their creativity. However, the bourgeoisie intelligensia consists of different groups holding at times directly opposite ideological views. Besides outspoken advocates of the interests of the ruling elite there are progressive — minded intellectuals having critical view of the capitalist realities and sympathesing openly with the exaacerbation of capitalist contradictions and the most democratic - minded section of the intelligensia breaks with the ruling class and openly takes sides with the working people and democratic forces.

It is important to stress here that the creative work is not only a specialized type of activity within the framework of a definite profession but, above all, a socially motivated historical work, i.e. shaping by men of their own social being. It is also important to note that cultural progress implies not mechanical assimilation of knowledge but an ability to use it in creative activity for the good of society. One of the key factors of accelerated cultural progress in socialist society is the upsurge of the creative activity of the masses.

Working people have never taken such a keen interest in creative activity as they do under socialism, which provides realistic opportunities for meeting the growing creative needs of the masses. By awakening the masses to creative activity on a historical plane, socialism advances them to an unprecedented level and releases their immense creativity. For the first time in mankind's history, the masses have been given realistic opportunities for raising their own creative individuals.

The spectacular progress of socialist culture is evidence of the masses possessing an inexhaustible wealth of creative talent which brought into full play under socialism. In other words, creativity is no longer the privileged of a particular social group but is a natural manifestation of the social activity of each normal citizen. The socialist social relations generate new, progressive and creative tendencies in cultural life, which are manifest both in the production and distribution of creative products. Socialism provides for everyone favourable conditions for the enjoyment of creative acts. Its main objective, however, is to secure the individual's participation in their production, exchange and distribution as well as in their creation. This signifies the importance of creativity in the evolution of man as an intelligent, creative being and makes it imperative to encourage him in every way as a socially creative individual, support his creative efforst, and aspirations towards innovation and penetration of the unknown.

On the other hand, any culture which has for its purpose the service of a narrow creative elite sooner or later inevitably loses its basic popular essence. In a society where creative products exist as commodities and their producers are estranged-alienated – from their consumers, the role of creative life of men is distroted. In the West the meaning of the principle "every thing for man" is "every thing for the consumer", every thing is an article of consumption in the language of Erich Fromm. The priority of consumption to creativity inevitably leads to a situation where consumption itself becomes restricted and monotonous. Spiritual performance develops within society. The values it offers to consumers are not a stimulus to their own creative activity but a fixed standard they may mechanically, thoughtlessly apply to actual relationships. The resulting situation is paradoxical: the more creative values are consumed by the masses the less spiritual freedom they have. The conditions of antagonism between physical and mental work, where the bulk of the people directly involved in material production is practically deprived of elementary rights to education and enlightenment, the elite has the decisive role to play in society's creative life. In the West the exploitation of talent, of mental works, which humiliate the creative's human dignity and cripples his originality, takes the forms which are as cruel as the exploitation of physical labour.

Creative work and socialism are inseparable phenomena: creativeness is an inherent feature of the new social system which itself the result of the creative thought and work of the mankind's outstanding representatives. The creative approach to everything enabled the Soviet society in a historically very short period of time to make a tremendous leap forward from the wooden phough to the spaceship, from the chip lamp to the atomic power station and from semi-literacy to the unprecedented bright age of science and culture. Nowadys the creative initiative of the masses is a constant factor of social progress. However the creative activity of the masses and dedicated labour can persist only if the social medium which nurtures them abounds in vital force.

Only under a system providing young people with equal educationed (and social, of course,) opportunities until they become of age, can the question of giftedness be solved satisfactorily. Only a society ensuring a healthy childhood for every child guaranteeing equality of access to the finest achievements of human genuis, equal opportunity for growth and development, and equal educational opportunities for all, can be regarded as truly just and promoting the free and full development of human giftedness.

The question of the giftedness of pupils calls for a critically objective scientific approach. There is no such thing as absolute giftedness and never has been. One can only speak of relative giftedness in regard to this or that type of activity. But one should not lose sight of what is known as special training. One of the requisites for resolving the problem of giftedness of young people is to find an effective answer to the problem of teachers. Normally and traditionally when the subject of giftedness comes up attention is fixed on the pupils. The teacher is left out of a discussion of the interaction between the teacher and his pupils. This is so for a reason: the idea has taken root in the West and is now fairly widespread that the individual's giftedness is genetically preordained by the unique biological heredity. In this view it is small wonder that the teacher is left out of account whereas a good teacher usually has more gifted pupils than the bad one and a gifted teacher generates gifted pupils. On the other hand giftedness can be realized only in practice: If one never tries his hand at this or that sort of human activity, he cannot know whether he has a giftedness to this or that kind of activity. The choice of this or that kind of activity makes the individual something as it were, placing him inside a particular sphere of activity where he can realise his potentialities.

In our day the ability to acquire knowledge is very much at a premium not only because of the rapid expansion. After all leisure time is a powerful factor contributing to the full development of giftedness. The true and full flowering of giftedness is inconceivable without the provision of an adequate amount of leisure time. Under socialism leisure time is used not only for rest but also, and mainly, for improving one's skills and engaging in creative activity contributing to the scientific and technical advance as well as to aesthetic appreciation: that is the leisure time available to the human being is used to enhance his creativity.

There are common ways in which children at different ages express their creativity: chief among them are animism, dramatic play, constructive play, imaginary compositions, daydreaming, white lies and humors.

Animism is the tendency to ascribe life to inanimate objects. Young children have too little knowledge and experience to be able to distinguish between things which have life qualities and those which do not. Animistic thinking begins around the time the child is 2 years old and reaches a peak between 4 and 5 years and then declines rapidly, disappearing shortly after the child enters school. The tendency of the child to endow everything with the same life qualities that he has should be encouraged by parents. They should read him stories or encourage him to look at comics, television programs or movies in which trees, toys animals and objects of all sorts behave like human beings. In trying to explain natural phenomena, such as clouds, stars, lightening adults should encourage children to think of them as having living qualities. Only as children gain more experience as they begin to understand explanations of the difference between animate and inanimate objects does their animistic thinking wane. Animism can, consequently, be regarded as a creative activity of early childhood. That animism gives the child pleasure connot be questioned. It adds enjoyment to his play with toys during the years when he is too immature to spend much of his playtime with other people.

Dramatic play — often loses its appeal about the time children enter school. The dramatic play is a mirror of the culture surrounding of the child : it dramatizes events of his everyday life. Every thing the child hears or sees is repeated in imitative form. Some parents regard dramatic play as a waste of time or as handicap to realistic achievement. They dis-courage their children from dramatic play directly by making fun of it and indirectly by not providing the toys and equipments needed to make dramatic play possible.

As children reach school age and are better able to distinguish between reality and fantasy, they lose interest in dramatic play and turn their attention to cnostructive play. The young child is pleased with whatever he makes. Constructive play manifests itself most clearly in drawing; the drawings of the young child are creative, not direct copies of people or things. He draws things as he remenbers them or as he would like them to be and he puts in details what interests him, such as buttons on a coat, while omitting essentials such as man's legs.

In imaginary composition is a person, an animal or an object the child creates in fantasy to play the role of a companion. Because much play requires playmates to be enjoyable, the child who lacks a playmate often creates an imaginary one. If a child is timid or has had unpleasant early social experience, he may prefer an imaginary playmate to a real one. When a child wants a friend, his imaginary companion will serve as a real friend. Imaginary companions, like real ones, may be either playmates or friends. Regardless of the role the imaginary companion plays, the child derives satisfaction from feeling that he has someone always present.

As like all kinds of play, daydreaming is an activity which is engaged in for the pleasure it provides. It is a form of mental play, and is usually called "fantasy" which is an illusionary release from unsatisfying reality or an imaginary satisfaction of wishes, any actual qualification of which has been forbidden by repression. Day dreaming differs from make-believe play in that the role of the child play in his daydreams is more herioc more fanciful and more remote from daily life. In his day-dream, he is the hero, the superman.

White lies are very common expression of creativity among children. They are different from a lie as adults think of it. A white lie is falsehood told by a child who actually belives it to be true. He has no intention of deceiving others and no motivation to do so.

Almost all highly creative have acknowledged the priority of motivational factors. It is not "special" intellectual abilities that distinguish the creative from other people; but his motivation, which is a combination of two passions: love of truth and thirst for fame. It is they that import to the creative that high psychological tension which leads to discovery. Therefore, the role of motivation stood out vividly in the very first attempt to study and ilucidate the essence of creativity. In the search for a landmark according to which highly creative potentialities could be ditinguished from the ordinary the differences should be attributed primarily to motivation rather than to special "mental endowments" as sometimes unjustifiablly assumed. Creative, dominant and full of initiative, have greater motivation with respect to intellectual achievement.

Chambers(1), for instance, who studied 740 American scientists, especially chemists, in the hope of establishing the signs by which creative thinkers could be distinguished from the non-creative, came to the conclusion that the former are more strongly motivated with respect to creative success both in the present period of time and at the preceding stage of their training. This sign of predominance of the intellectual drive over other motives is so great that, in Chamber's view, it can be used in identifying truly creative worker. The less creative, in his view, is concerned primarily with finding a conventient opportunity to combine research with teaching and carrying out administrative duties, while the detedmining choice for the creative is to conduct actual creative research and to find challenging problems.

It is of utmost importance to indicate the role played by scientific experiment nowadays in the domain of scientific creativity. Experiment differs essentially, as it is well-known, from the contemplation and observation of nature to which the creative of the ancient Greece, for instance, mostly confined themselves. Experiment, in its scientific aspect, is purposeful, we give the name experimenter to the scientist who applies methods of investigation, whether simple or complex, so as to make natural phenomena clear, or so as to alter them with some purpose or other, and to make them present themselves in circumstances or conditions in which nature does not show them. In this sense, observation is investigation of a natural phenomenon, and experiment is investigation of phenomenon altered by the invetigator. In science of observation, man observes and reasons expermentally, but he does not experiment: in this sense a science of observation is passive. In the science of experimentation, man observes but in addition he acts on matter, analyzes its properties and to his own advantage brings about the appearance of phenomena which doubtless always occur according to natural laws, but in conditions which nature often has not yet achieved. With the help of these active experimental sciences, man becomes an inventor of phenomena, a real foreman of creation. And under this head we cannot set limits to the power that he may gain over nature through future progress in the experimental sciences. In other words, experimenters put questions to nature and as soon as nature speaks they must hold their peace. They note the answers and in every case accept the decisions of nature. They force nature to unveil itself by attacking it with all manners of questions and through experiments but never answer for it nor listen partially to its answers or by taking from the results of an experiment only those which support or confirm their initial preconceived ideas. In other words, man tries to inderstand nature in order to change it and change himself to satisfy all his needs, biological and social.

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(1) **Chambers Y.A., Relating Personality Factors to Sceintife creativity, New York, Psychological Monography, 1967, Vol. 78, No. 7.,**

B: A Tentative Hypothesis Regarding The Btain Mechanisms Of Creativity and Genuis.

With this we shall conclude our study of the brain mechanisms of creativity and genuis; we have arrived at a new turning point in our route. Like travellers investigating unknown mountain paths we have proceeded with the utmost caution and concentrated our whole attention on each step taken. We can now cast a glance back at the path traversed. Now that we have made clear the structure and functions of the human brain from the standpoint of Soviet investigators. It cannot be disputed that our scientific horizon has become much wider than was before, when we were only concerned with creativity in the Western literature. Nevertheless, we have still not yet attained the final point of our scientific journy, the mountain peak from which there would open before us a view of the flowering valleys. This new branch of neuropsychology is indeed a fascinating one, satisfying, as it does, two inseparable tendencies of the human mind: the constant endeavour to lay hold of new truths and the continued protest against any claims of finality in the attainment of knowledge. Here the mountain of the unknown will long remain immeasurably greater than the fragments that we can break off, that we can learn to know.

In his paper read at the second International Neurological Congress, London, August, 1935, Pavlov said: "Until the time when *homo sapiens* appeared animals were connected with the environment so that the direct impressions fall upon the different receptors and were conducted to the corresponding cells of the central nervous system. These impressions were the several signals of the external objects. However, there arise in the developing human an extraordinary perfection, the signals of the second order, the signals of the primary signals in the form of words — the spoken, the heard, the seen word. Finally it came about that through these new signals everything was designated that the human being perceived both from the environment and from his inner world, and these signals commenced to serve him not only, in communating with other men, but also where he was alone. The chief significance attached to the world was the performance of these new signals — yet it remained a word, only a second signal of reality. And we know that there are numbers of people who operate only with words from which they deduce everything, would experience everything without coming into contact with reality. And from this they wish to direct their own life as well as to direct the lives of others. Thanks to this second signal of signals and to its constant effect in various espects of life, all of the human race can be separated into several types: artists, thinkers and a middle type. The latter unite in proper portions and activity both signals. These two divisions can be seen among individuals as well as among nations". "1" In his speech at the Academy of Sciences of the USSR, 1932, Pavlov specified the essential features of the artists and thinkers and the main difference between their higher nervous activity

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(1) **Pavlov, I.P. Lectures on Conditioned Reflexes, London, Lawrence and Wishart, 1941, Vol. II PP. 162—163.**

in these words: "Life deffinitely reveals two categories of people — artists and thinkers. Between them is a marked difference. The artists, including all types of writers, musicians, painters, actors, etc., comprehend reality as a whole, as a continuity, a complete living reality, without any division, without any separation. The other group, the thinkers, pull it apart, kill it, so to speak, making out of it a temporary skeleton and then only gradually putting it together anew, piecemeal, and thus, try to give it life in order that they might also succeed... It is so exceedingly hard that we find in one person a great artist and a great thinker(2)". It seems to me that there are strong physiological reasons, although not entirely convincing, to understand the matter thus. In the artist the activity of the cerebral hemispheres flowing through the whole mass, involve least of all the frontal lobes, concentrating chiefly in the remaining parts; in the thinkers, however, the converse is true". (3)

When Pavlov(4) postulated that one of the basic functions of the cortex is to break up the complexity of the external world into separate elements, he made an important step forward toward the concrete interpretation of the processes of reflection and of its mental basis. By stipulating that all parts performing this complex function were united into a single mechanism, bearing the name of analyers, he made it possible for a better understanding to be obtained of the basic principles of the working of the cerebral cortex. This showed that besides the apparatus responsible for the analysis at a lower level an apparatus for higher analysis — and synthesis — is found in the cerebral cortex, distinguishing essential signs into definite structure, differentiating them, and forming complex programmes acting as a pattern of behaviour. In the light of this approach the cerebral cortex with good reason may be regarded as the central part of a series of exteroceptive, proprioceptive and interoceptive anaiysers, the work of which is based on regulation of the highest forms of human mental activity. However, the analyers represented in the cortex never work in isolation from each other, as already stressed. In the lower levels of evolution, in every zone of the cerebral cortex there are neurons belonging to different analysers, so that each of these zones is a system combining impulses derived from various sources. In the higher grades of evolution, the neurons belonging to different analysers are concentrated in strictly differentiated areas of the cerebral cortex, and between these areas there are zones of overlapping, including in their composition elements belonging to different analysers, as was stressed repeatedly. These overlapping zones are mainly primate cerebral formations and they reached their highest level of perfection in man. In the early stages of mammalian development, the cerebral systems preparing for movement were not so clearly subdivided between two units and a single sensori-motor region consisting of afferent — kinesthetic — cells and motor cells proper, could be distinguished in the cortex. In the stages of the development, in primates and, in particular, in man, differentiation took place and the two parts of the functionally single system, one for the preparation of movements and the other for carrying them out, became clearly separated. The posterior zones of the semimotor cortex, providing the kinesthetic basis of movement, became separated into the postcentral region, maintaining its afferent functions and forming a part of the second brain unit-already detailed —, while the anterior zones, including the motor and premotor areas, took over the special responsibility for the efferent organization of movement, and they both form a part of the third brain unit.

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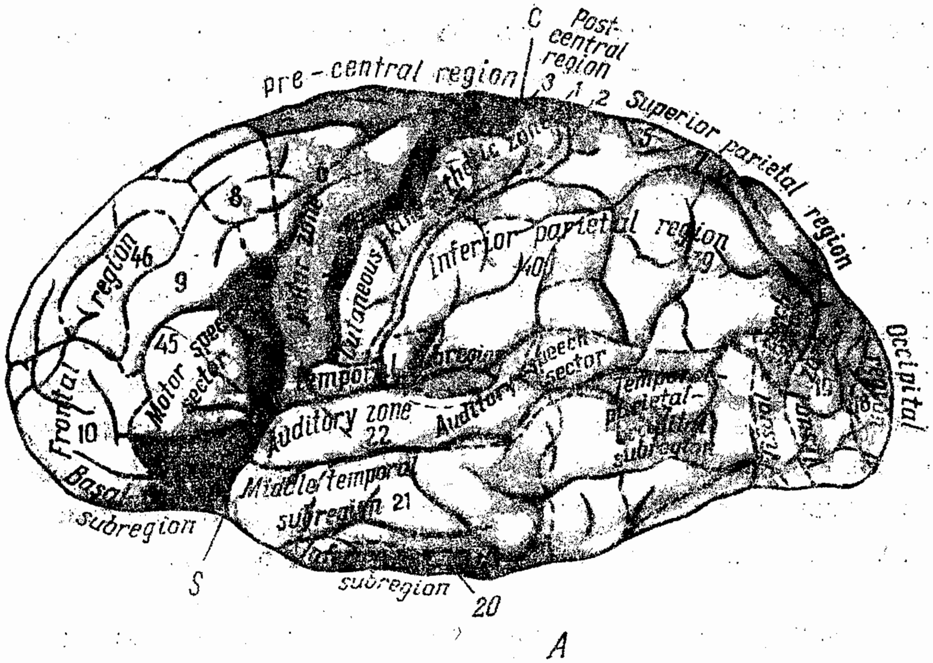
(2) Goethe, Leonerdo da Vinci, Lomosonov are examples.

(3) Pavlov, Lectures on Conditioned Reflexes, London, Lawrence and Wishart, 1941, Vol. II, PP. 112x113.

(4) Pavlov, I.P., Selected Works, Moscow, Foreign Languages Pub. House, 1955, Part 6: PP. 288—312.

Just as with other modally specific zones of this brain unit — the third one—, secondary zones are superposed above the primary — cutaneous — kinesthetic cortex. These zones comprise Brodmann's areas 1,5 and part of areas 7 and 40, in which, just as in the other secondary zones, the upper layers of the cortex begin to occupy a substantial place. The premotor region — Brodmann's areas 6 and 8 — is the site of the mechanism which is superposed above the subcortical level of the spinal system and also above the cortical systems of the precentral gyrus. An essential feature is that the premotor zones becomes powerfully developed only in the stages of evolution of mammals. Whereas in lower monkeys the primary motor area — Brodmann's area 4 — is sharply predominant, and the premotor cortical zones — Brodmann's area 6 — occupy only an insignificant place, in man these relationships are reversed, and the premotor cortical cortex now occupies the greater part of the precentral region. The increasing importance of the secondary zones of the motor cortex — the premotor area — in the organization of the increasingly complex skilled movements is a unique human cortical feature. Morphological studies have shown that the distribution of cells varies from one layer of the motor cortex to another. According to Moscow Brain Institute in the primary motor area — Brodmann's area 4 — a much larger number of cells is concentrated in the cortical layer 5 — the effector layer —, whereas there are comparatively few cells, in the layer 2 and 3 — the associative layers —. Meanwhile, in the secondary premotor zones of the motor cortex — Brodmann's area 6 — the number of cells in the upper layers of the cortex rises sharply, and the number of cells in the same layers in the still more complex tertiary cortical zones — Brodmann's area 10 — is even greater. This reflects the increasing role of the premotor, and then of prefrontal zones in the organization of complex human motor behaviour.

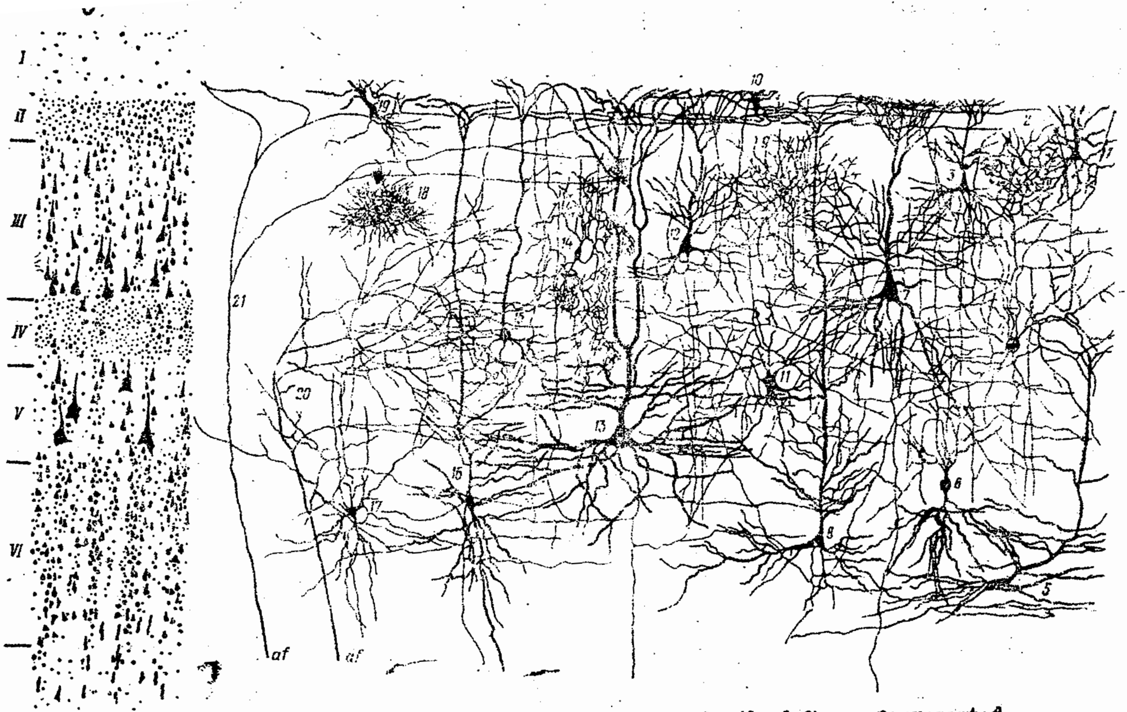
Investrgation of the morphology and morphophysiology of the brain, which have undergone considerable development in recent decades, have shown that human cerebral hemispheres and, in particular, the cerebral cortex, are highly complex, differentiated nervous structures in which may be distinguished both highly specialized areas and also areas with more general functions. Among the righly specialized areas must be included the central representation of the individual extero-and proprio-ceptors of the various analysers: visual-situated in the occipital, auditory — in the temporal — and cutaneous — in the postcentral. And also the motor, analyser located in the central and premotor regions. These are also the cortical nuclei — the primary — projection — zones of the cerebral cortex. Above them are superimposed the seconday-associative-zones of the cortical nuclei of the analysers, which are differentiated for the first time in the carnivora, and in man they cover muct larger area than the



Maps of the distribution on the surface of the human cerebral hemispheres of the cortical ends of the analyser systems and of the cyto-architectonic regions and fields of the cortex corresponding to them, *A*, lateral surface of a hemisphere; *B*, medial surface; *C*, central fissure; *S*, Sylvian sulcus. Figures designate fields within regions. The cortical zonesof the following analysers are represented: visual by the occipital region; auditory by the superior temporal sub-region; cutaneous-kinaesthetic (zone of bodily sensation) by the post-central region. The motor zone of the cortex is represented by the precentral region. The visual zone embraces central field 17 and peripheral fields 18 and 19; similarly, the aduitory zone embraces field 41 and fields 42 and 22, the cutaneous-kinaesthetic field 3 and fields 1 and 2, and the motor zone field 4 and fielrs 6 and 8. The zones where analysers overlap (interanalyser zones) are represented by the superior (fields 5 and 7) and inferior (fields 40 and 39) corresponds regions, the middle temporal (field 21) and temporal-parietal-occipital (field 37) sub-regions; the frontal region also corresponds to them (fields 9, 46, 10). Special motor-speech (fields 44 and 45 of the inferior frontal gyrus), auditory-speech (the posterior part of field 22 in the superior temporal sub-region), and visual-speech (adjacent sectors of visual field 19 and inferior parietal field 39) sectors are distinguished. The medial surface of the hemisphere (the limbic region) and the basal surface (basal frontal and inferior temporal sub-regions), together with the insular region oying deep in the Sylvian sulcus,are occupied by lower (functionally speaking) formations of the neocortex. Thesesectors of the neocortex, taken together with the formations of the intermediate cortex, archiocortex and paleocortex contiguous to them are predominantly related to the olfactory and taste analysers, to regulation of the state of the organism's internal medium, and to its vital reactions.

primary zones. In their neuronal structure they differ from the former by the considerable predominance of cells with short axons and of stellete cells situated in layers II and III. The secondary zones — the segments of the cortical muclei — of the corresponding analysers, while retaining their functional specificity, performs a much more complex system of information and enabling differential systems of reactions to be produced in response to visual, acoustic and tactile stimulation. While they are much less concerned than the neurons of the projection areas in the peformance of the highly specialized functions of individual analysers the neuronal groups of these secondary areas, developed in the later stage of evolution, are responsible for the no less, and perhaps even more important, functions of the formation of complex systems of excitaion assosiated with the combined operations of a whole sets of analysers. The secondary zones differ considerably from the primary zones over which they are superimposed both in their structure and in their functions. Brodmann's area 17, for instance, constitutes the primary zone of the occipital cortex, and areas 18 and 19 constitute the secondary zones. The secondary zones of the auditory cortex Brodmann's areas 22 and 21 — have the same structure, as previously stressed.

The zones occupied by the cortical unclei of indivdual analyers consitute the greater part of the cerebral cortex of the higher vertebrates, but they do account for less than half of the human cerebral cortex. Much of the human cerebral cortex is occupied by zones formed only in the latest stage of evolution, conventionally known as tertiary and which, according to all the information, are the result of overlapp-



Map of the neuronal structure of the human brain. On the left are represented the cyto—architectonic layers of the cortex; *af*, projection (20, and association (21) afferent fibres: 1, 3, 5, 7, 8. 12, 13, 15, 16, efferent neurons with long axons (pyramidal and spindle-shaped cells); 2, 4, 6, 9, 11, 14, 17, 18, 19, internuncial neurons with short axons (stellate cells) (after Poliakov, 1953).

ing of the cortical nuclei of the individual analysers. There is reason to suppose that the powrful development of these zones, which may be observed in primates and which may be seen exceptionally clrealy in man, is associated with the development at complex forms forms of investigative activity requiring constant interaction between analysers. With the change of to social forms of existence, in which objective activity and the second signal system began to acquire exceptionally complex forms of integrative activity, these zones became particularly well developed. This is a uniquely human cerebral feature distinguishing the cerebral human cortex from that of the rest of animals.

In modern view the human cerebral cortex is regarded as the central end of a complex system of analysers, represented both in highly specialized perfection zones - or cortical sectors of nuclear zones of cerebral cortex —, and in the system of secondary zones and zones of overlapping, possessing a lower degree of specificity, yet capable of carrying out the complex operations of cerebral cortex requiring the combined participation of many analysers. Investigations have shown that the nucleus of each sensory area of the cortex in animals and man is a highly specialized apparatus for analysis of signals of one particular modality. It consists of vast mosaic of different endings and internuncial cells, which receive appropriate signals and, by breaking them up, make them amenable to control. Facts suggest that outside the zones forming the central part of the cortical cells of a given analyser there are other elements of analysis, more complex in structure forming the overlapping zones which integrate the excitation arriving from individual analysers and facilitate for their combined working. Thus, it is firmly established fact in phylogenesis that during or in the course of mammalian evolution — when neocortex first developed — special sections (the central fields of cortical zones of analysers) became differentiated within the specialized regions of the neocortex — visual, auditory, cutaneous and kinesthetic — : fields 17, 41, 3 and 4. Because of their structural and functional features these fields are adapted for the maximum detailed breaking down of the individual stimuli and are thus the material substratum in man of finally differentiated sensations. This means that apart from the primary — central — field of the cortical zone of each analyser there are secondary-peripheral-fields (18 and 19, 42 and 22, and 2, 6 and 8) which are linked with perceiving surface via a larger number of supplementary switches in the subcortical sections of the analyser systems. These cortical formations perform more complex, mediated forms of reflection of the external world; and through them the functions of perception, imprinting and correction of more or less complex combinations of stimuli are performed.

It is, to stress once more, the occipital zones of the brain constitute the cortical centre of the visual system. The primary areas of the occipital cortex have the elementary funcations of vision and constitute the areas where fibers from the retina terminate — Brodmann's area 17 —. The secondary zones of the occipital cortex differ considerably from the primary — projection — zones over which they are placed both in their structure and in their functions. They are projection — association zones — Brodmann's areas 18, 19 — which have recently been named the intrinsic cerebral areas. They have also undergone substantial changes by comparison with the primary zones in the course of evolution. Whereas in lower monkey's — with their powerfully developed visual cortex — the primary or projection area (Brodmann's 17) is much more extensive than the secondary zone, in man this ratio is reversed and the secondary visual zone — Brodmann's 18, 19 — is now distinctively larger than the primary visual cortex. Its role, which is responsible not for reception, but for coding — analysis and synthesis — incoming visual information, is considerably increased in man by comparison with his antecedents on the scale of evolution. Thus, the distribution of nerve cells in the cortex of the primary and secondary occipital zones — Brodmann's 17, 18, 19 — differ very considerably. Whereas cells of afferent layer I are distinctly predominant in the primary visual cortex — Brodmann's area 17 —, these cells are much less numerous in the secondary visual cortex — areas 18, 19 — where most cells are located in the upper association layers II, III. The morphological and physiological features, distinguishing the structure of the secondary zones of the visual cortex, also determine the role they play in organizing complex visual perception. The secondary zones of the visual cortex, with their complete structure and their facility for the extensive spread of excitation, play the role of synthesizing visual stimuli, coding them and forming them into complex systems. Consequently, these zones play a decisive role in the provision of a higher level of processing and storing of visual information.

The auditory cortex occupies the lateral — convex — portions of the temporal region of the brain and just, as in the case of visual or occipital region, it is divided into primary zones and secondary zones. The secondary zones of the auditory cortex — occupying the lateral, convex portions of the temporal lobes in man, corresponding to Brodmann's area 22 and part of area 21 — have the same structure of the secondary zones of other sensory area. They consist predominantly of cortical layers II and III, the greater part of which is composed of cells with axions. In man, with characteristically well-developed secondary zones of his auditory cortex, these zones play a vital role in the differentiation of groups of simultaneous stimuli and also of consecutive series of sounds of different pitch or rhythmic acoustic structures. They also reflect an essential, but by no means the most important, aspect of the work of the secondary zones of the human temporal cortex. Their importance lies in the fact that they are the fundametal apparatus for the analysis and synthesis of the sounds of speech, the quality which distinguishes human hearing from the hearing of animals.

The overlapping zones of the human brain in which there is overlapping of the cortical boundries of different analysers — i.e. regions in which, according to the modern view, combine activity of different cortical areas taken together comprise about 43 per cent of the total mass of the cortex, so that it appears that the evolution of the cortex proceeds mainly on the basis of formations responsible for this integrative activity of the central nervous apparatus in relation to particular fundamental systems. This evidence fundamentally contradict the idea of isolated centres and confirms the belief that the brain functions as a series of systems.

In the light of what has repeatedly been affirmed it is clear now that in the course of evolution the topographical relations between the cortical representations of the various analyser systems have become more complicated in connection with the reconstruction of their functional interrelationships brought about by the effect of an increasing complicated external environment on the organism. In addition to ever more detailed structural differentiation within the primary central- and secondary-peripheral-fields of cortical zones of the analysers, there is territorial expansion of the cortical zones of the various analysers with an ever greater mutual coming together of these zones where they overlap. These overlapping or interanalyser zones are quite fully represented in primates by anatomically specialized formations. They embrace the upper (fields 5, 7) and the lower (fields 39, 40) of parietal regions, the middle temporal field 21 — and temporal — perietal — occipital (field 37) subregion. The same group may also include difinite fields (9, 10, 46) of the frontal region which constitutes nearly quarter of the whole extent of the cortex in man.

It is important to stress here that intellectual activity is a particularly complex form of mental activity, taken place only when problem facing the individual in the course of his life — professional and otherwise — demands preliminary analysis and synthesis of the situation containing that problem and special auxiliary operations by means of which it can be solved. Any investigation of the intellectual processes must therefore create a situation in which the subject has no ready — made, previously established means of attaining the desired goal and in which he must analyse this situation, picking on its essential components and correlating them with each other, formulate hypotheses, develop a strategy and select definite operations or tactical methods for its solution. The essence of the whole process is vividly expressed by one of the leading Soviet psychologists, Leontieve, starting with the child at his early stages of learning arithmetics. Since creativity is associated with the solving arithmetical problems in the early stages of school teaching, we shall elaborate this point in a detailed ilucidation : "Of particular theoretical and practical importance is the intellectual properties and processes... Internal mental processes are formed by means of the transformation of processes which initially take the form of action based on external objects. This hypothesis has been confirmed and clarified in a new way as a result of more recent investigations. These involved a detailed study of the conditions and stages of such processes as mental arithmetic, operations involving geometrical relations, and so on. It was demonstrated that the formation of internal mental processes does, in fact, begin with the mastery of external actions with objects. For example, addition is done at first in the form of an external movement-by means of actually shifting one group of objects and joining them to another; after this the child counts them together. Initially this is done by external movements of the finger or ruler, accompanied by a verbal naming of the ordinal numerals. Later this whole process is modified : the child goes on to counting groups of things but at first still preserves the same method of operation with external, real material. At the the second stage the process loses the character of an external action with objects. It is mastered in external speech, then in internal speech, and, as a result of this, is abstracted from the concrete material conditions and acquires a more generalized charcter. Even here the structure of process does not change, but reproduces that of the corresponding external operations. For example, when the child begins for the first time, to count to himself, he often still uses the method of adding by units, although now in a purely oral form. The decisive change comes only at the third stage, and consists of a specific shortening of the whole process, which simultaneously becomes automatic and is tranformed into a dynamic stereotype. It is at this moment that the mechanisms of the corresponding psychic function are formed". "1".

This abreviation of a process that has already become internal radically changes its structure. For when ideas and concepts (which are only the generalized reflection of things) are being manipulated, there is no need to reproduce all the processes necessary when one is working with real things. Many links of the process become superfluous, are not consolidated, become inhibited and fall out. Thus, a child who has learned to add numbers from one to ten by means of recounting in his head, will, in future, begin to count by passing straight from the numbers to be added to their sum.

Speaking in general terms, the method of formation of complex reflex systems, the functioning of which is manifested in the form of a capacity for this or that intellectual action, mathematical and otherwise, has been described by Leontieve in the previous passage only in its more general aspects. In

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(1) Leontiev, A.M. "The Nature and Formation of Humanization of Human Psychic Properties" in Simon, B., editor, Psychology in the Soviet Union, London, Routledge and Kegan Paul, 1957, P., 230.

reality it is much more complex and can vary in each individual case. In particular, these very systems can acquire different structures in the process of their formation and these structures are sometimes inadequate. Thus pupils sometimes advance to more complicated intellectual operations without having mastered the necessary methods, and perform these operations by the primitive methods characterizing of earler stages. Since, in school practices, the quality of the performance of a task is often judged solely by the result arrived at, such pupils appear for a time to be successful; but, when the next step is introduced they cease to be able to cope with their school tasks and show complete inability to master the succeeding skills.

Investigation of cases of inability of fully to perform certain definite intellectual actions shows that this is only a question of an incorrectly formed functional systems which can be successfully reconstructed. To do this it is necessary to bring to light the undeveloped or incorrectly developed links and to take the pupil back to the stage at which the the links in question are formed in their elementary external form. Generally speaking, in order to have an understanding of the essence and structure of ability for mathematics it is necessary to know about incapacity in mathematics, in what this consists. We may say at once that we refer here to relative incapacity since absolute incapacity does not exist. Every normal child given correct teaching, can more or less, successfully master the school course in mathematics, acquiring the relevant knowledge and skills. Relative incapacity for mathematics implies that the pupils concerned find difficulty in studying mathematics and cannot count on great success either in the sense of rapid progress or in level of achievement. Since mathematics is, in essence, a science concerned with the abstract, generalized properties of objects and their relations it is natural to pose this question: could predominance of the visual — image component of thinking over verbal — logical component be one of the internal causes of relative incapacity for mathematics? It is possible to suggest that predominance of the verbal — logical aspect of thinkitg over the visual — image aspect is one of the components of mathematical ability. More important in this respect is that the stage or level of development of the verbal — logical component of thinking which plays the decisive role. Pavlov has spoken of interaction of the two signal systems and of the predominance of one or the other and of their relative equilibrium. Fof certain purposes this classification is adequate. However, we are faced with the need for the extention or broadening that classification to include the characteristic activity of the two signal systems from the point of view not only of their iaterrelations but of their level of development. This is the physiological side of the differences between children in their mathematical ability. The other, and no less important, is the difference in their educatioanl climate, especially the methods followed in school teaching. Pupils who feel inadequate in their mathematical abilities, because of bad teaching, display intellectual passivity regarding school work in mathematics. In order to secure their progress, it is important to overcome their intellectual passivity, first, by overcoming their negative emotional attitude to intellectual activity and replacing it by new positive emotions; second, by extercising them in all these mental habits and skills necessary to the security of knowledge.

It is of interest, but no less essential, to state that a discrimination must always be made between the nature of pupil's mistakes in solving their mathematical problems. Furthermore, even in the cases in which the distinction between correct and incorrect - solutions is clear, we cannot treat all errors alike. Kohler,(1) for instance, distinguishes what he called good errors and stupid errors. In the former, the animal does not make a stupid mistake but rather an almost favourable impression, if only the observer can get right away from preoccupation with human achievements, and concentrate only on the nature of the behaviour observed. Such situations may, in a certain sense, be absolutely appropriate to the situation, although they do not solve the problem. Thus one ape who does not have a stick long long enough to draw the object to him, and who has not yet solve the problem of making a long stick out of two short ones, established contact with the prize by means of two sticks laid end to end; or two animals suddenly lift a box that stands too low, and hold it high against the wall. In such cases the structure of the problem is clearly understood; only the means are looking for its correct solution is lacking. Likewise in the case of correct solutions a similar distinction seems necessary. There is a difference between a correct solution achieved by rote and another which is the result of geniune grasping of the requirements of the problem. Clearly only the latter is a creative achievement. Wertheimer(2) has presented many examples of both kinds. Thus it seems not only that it is often difficult to know whether a given thinking process is correct, but also that among errors and among

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(1) Kohler, W. The Mentality of Apes, New York, Harcourt, 1927.

(2) Wertheimer M., Productive Thinking, Harper, New York, 1945.

correct solutions themselves we must make distinctions. Some errors and some correct solutions are creative, others are stupid or pedestrian. Again correctness fails us as a criterion of creative thinking. And yet we can not simply dismiss it. We demand a relation to reality in the creative solution; we do not ordinarily call the "inventions" of the abnormal creative. This is, at least in part, because these "inventions" tend to be unrelated to the task at hand. The creative solution is not merely an expression of the individual, but must do justice to the requirements of the problem before him – requirements which the crazy solution ignores. Thus, the creative solution, whether or not it is correct, is one which does justice to the requirements of the problem. On the other hand, it is indispensable to discriminate between genuine and stimulated or dull problems. The following questions may help in making such discrimination. Does the problem naturally suggest itself within some situation of personal experience? Or is it an aloof thing, a problem only for the purposes conveying instruction in some school topic? Is it the pupil's own problem or is it the teacher's or textbook's problem made a problem for the pupil only because he cannot get the required mark or be promoted or win the teacher approval unless dealt with? Is it imposed from without? Is it too difficult? A difficulty is an indispensable stimulus to thinking, but not all difficulties call out thinking. Sometimes they overwhelm and submerge and discourage. The perplexing situation must be sufficently like situations which have already been dealt with so that the pupils have some control of the means of handling it. A large part of the art of instruction lies in making the difficulty of new problems large enough to challenge thought and small enough so that, in addition to the confusion naturally attending the novel elements, there shall be luminous spots from which helpful suggestions may spring.

Arithmetical problem always consists of a goal - the statement of the problem in the form of a question to which no ready - made answer is available, (and the conditions, from which a scheme for the solution can be proposed by analysis, alternatively a strategy leading to the required solution can be decided. This strategy, especially in words as hypothesis, indicates researches for the individual operation which will be used to obtain the necessary results. The process of the solution of the problem ends with a comparison between the method used and the result obtained, on the one hand, and on the question and the conclusions of the problem, on the other hand. Different problems have different sturctures, and it is possible to arrange their structures in the order of increasing complexity. The simplest problrem has a simple algorithm of solution and no special searching is required. For instance : how many legs have two boys ? More complex forms of this problem require the performance of an intermediate operation, which is not expressed in the words in the problem, so that the solution of the task breaks up into two steps : a boy has two books. Another boy has two books more. How many books have they together ? The solution of problems with complex algorithms, requiring programmes consisting of a series of successive components, is much more difficult, especially when the components of the programme can be found only after a detailed analysis of the problem and the production of specific strategy : there are eight books on two shelves. There are twice as many books on one shelf as on the other. How many books are there on each shelf ? To solve this problem, in addition to the original condition of the two shelves, the additioned items; "three parts" must be introduced and the number of books on each of these auxiliary "parts" most first be calculated. Finally, perhaps the most difficult problems are those which may be described as conflicting and in which the correct method of the solution involves the inhibition of the impulsive direct method: a candle is 15 cm long. The shadow from the candle is 45 cm longer. How many times the shadow is longer than the candle? The tendency here is to perform the direct operation : $45 \div 15 = 3$. This must be inhibited and replaced by the more complex programme : $15 + 45 = 60$. $60 \div 15 = 4$. It will be evident how the solution of problems of these types represents a series of increasingly complex psychological actions. Thinking is a special form of cognitive activity arising when a person is confronted with a problem scientific or otherwise, and no ready - made answer is available. The subject who tries to solve the problem in an organized manner must first discover its conditions, pick out the essential elements, create a hypothesis for solving the problem and, finally, select the methods or operations by which this may be done. These constitute the first preliminary phase and is followed by the second which is exclusive in character and consists of application of a series of operations leading to the required answer. The intellectual process ends with the last phase: the matching of the answer obtained with the conditions laid down by the original problem: If the solution agrees with the condition of the problem, it is adopted and the process is complete; otherwise the process of seeking the required solution continues.

Thinking arises, however, only when the individual has an appropriate motive which makes the problem urgent and its solution essential: when the subject is confornted by a baffling situation for which he has no ready-made solution. Thus: the origin of thinking is the presence of a problematic situation which the subject must solve under certain conditions. The subject must, therefore, begin, first, to investigate in order to discover the proper path leading to an adequate solution: "exit," way out. In this stage he restrained his immediate impulsive responses in order to be able to investigate the conditions of the problem, to analyse its components, to locate or identify its most essential features, and their interconnections. This work of preliminary investigation into the conditions of the problem is a vital and essential step in any concrete process of thought, without which no intellectual act could take place.

The next stage in the process of thinking is the selection of one from number of possible alternatives, "candidate solutions" and the creation of a general plan (scheme) for the performance of the task deciding which alternatives are more likely to succeed, and at the same time rejecting all inadequate alternatives. The formation of a general scheme for the solution of the problem and the choice of adequate systems of alternatives bring the individual to the next phase of thinking, which is choosing the appropriate ways and conidering which operations will be adequate for putting the general scheme of the probable solution into effect.

It is important here to note that *the process of using the approperiate operations is naturally the operative stage of* *the intellectual act rather than its creative stage.*

The process of thinking, then, passes through several stages. It starts with an external series of successive external actions (trials and errors), processes extented to internal speech, in which the necessary searches are made, and concludes with contraction and the transition to a specific internal processes. In this the subject is able to obtain assistence from ready - made systems of codes: (linguistic and logical in discursive verbal thinking; numerical in the solution of arithmatical problems) which he has learned. The existence of these well assimilated internal codes, which form the operative basis of the "mental act", thus also form the foundations for performance required intellectual operations, and, in the adults, who have mastered the use of these algorithms, it begins to provide a solid foundation for the operative stage of thinking. The use of algorithm leads the individual to the next phase of the intellectual act regarded for many decades as the last, but in the modern view, still not its final stage. *This phase is the actual solution of the problem or the discovery of the answer to the question embodied in the task.*

It is only in the last decade that it is known that *the discovery of the solution does not conclude the intellectual act, but is merely the prelude to the final stage.* The fact that the process of thinking does not end with the discovery of the answer has been proved by the work of many Soviet investigators. The stage of the discovery of the solution must be followed by " a stage of comparing the results obtained with the original conditions of the task (this stage is called the stage of action accepitor" as Anokhim termed it.⁽¹⁾ If the results do agree with original conditions of the problem the intellectual act is complete, but if they do not correspond to the original conditions, the search for the necessary strategy must begin and the pocesses of thinking must continue until the adequate solution, in agreement with the conditions, is finally reached.

Whereas sensations reflect only the separate qulities of things as a whole, the unity of its various sensorily reproduced properties is reflected in perception. However, the the process of sensory reflection is not confined to sensation and perception. A high form of sensory reflection is representation. This is imaginal knowledge of objects that we have perceived in the past but that are not acting on our senses at the given moment. Representations, or images, arise as a result of the perception of eternal influences and their subsequent retention in the memory. The images with which man's consciousness operates are not restricted to the reproduction of what is sensorily perceived. A person may creatively combine and with relative freedom create new images in his consciouness. The highest form of representation is productive, creative imagination.

There is, on the other hand, a qualitative difference between representation and thought. But this difference must not divorse them from each other. Theoroetical thinking, which takes the form of concepts, judgements and infere-

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(1) Anokhim, P.K. "Electroence phalographic Analysis of the Conditioned Reflex" in Luria, A.R. and Others, Psychological Research in the USSR, Moscow, Progress, 1966, PP. 240—267.

nces, is the reflection of the essential, law - governed relationships of things. Aspeets of the world that are inaccessible to sense perception are open to though. On the visible, tangible, audible and so on, we are able, thanks to our ability to think, to penetrate into the hidden, intagible and inaudible.

Scientific research begins by stating a problem. The concept of the problem, as a rule, involves an unknown. However, in the stating a problem and, even more so, in solving it the individual must have facts. In other words, to state and solve a problem, to test the propositions made, the scientist for instance, must have knowledge whose objective ruth has been firmly established. This arithmatic knowledge is the facts on which the course of inquiry is based. Hence facts are often colled stubborn things. They have to be accepted whether the scientist likes them or not. These facts are those which have been proved to be objectively true and remain so no matter in what system they are included. Therefore, fact gathering is an essential part of scientific research, but in itself it does not solve problem. Every scientist knows that without imagination, without inventiveness, without the ability to conceive hypotheses and plans, nothing but mechanical operations can be performed.

Creativity, as long as it does not begin to function as an actual intellectual force, exists as a tendency or potentiality. The question here is to determine when it becomes active as an actual force. For the Western psychologists, as already stressed, creativity is from the beginning and "actual" force, which directs the individual's development.

Soviet psychologists, on the other hand, excludes the existence of creativity (and all other mental abilities) before the appearance of the activity which first makes it effective. All psychological functions are formed and developed only in the process of the activity reguires it - a human psychological function does not exist outside the corresponding activity of man and the tendency or potentiality from which it develops is too indefinite and plastic. Fore example, man is born with the tendency or potentiality to speak. But if the child did not live in the society of men - or among animals - this tendency would not develop at all. Conditions of life and, above all, upbringing and education, determine which language the child learns and the degree to which he learns it. This means that creativity has a historical character since human activity always takes place under conerete social and historical conditions. Different kinds of human activity are formed, changed and disappeared depending on their conditions; and so do human psychological functions. Morever, it is only human mental functions are historical in character, but olso their natural tendencies. Therefore, it would be false to assume that these tendencies, even in their present form, are the result of a purely biological heredity. In the course of man's history and especially of the historical development of work and language, numerous differences in natural individual mental abilities are bound to develop. The ever growing divisions of labour plays a decisive role in this process.

It is important to stres here that the conditions of life and work leave their imprint upon the individual's anatomical and physiological organization and upon his nervous system. These results are to some degree passed on by heredity and consolidate in the descendents. Without such a heredity, there could have been no humanization of the animals-like ansesstors of the *homo sapiens*. Pavlov experimental investigations showed that the acquisition of certain conditional reflexes by animals facilitates the development of these same conditional reflexes in the descentents of the animals experimented upon. Within the series of generations always subjected to the same experiments, the conditional reflex generally becomes an unconditional reflex. This gives us a key to the understanding of the historical growth of the hereditary differences and, at the same time, offers us the possibility of minimising such differences.

The infant is anything but a passive observer of social phenomena. He is always active - he tries to put into action through his own activity everything that he has seen and that he has learned from others, even though so much cannot as yet be accessible to him. This is the ground on which contradictions arise between the diversity of the surrounding world that opens itself to him and the limitations of his actual possibilities of action. The new things that the child discovers in the world around him are, above all, the kinds of human activity and men's attitude towards things. Creative activity of the child manifests itself in his play through which he becomes familiar with certain events that take place in his surroundings. Therefore, the creative play of pre-school age children must not be viewed as meaningless pastime and unimportant for their mental development. Rather, the best attempt must be made to direct this play and enrich it. On the other hand, creative play is, as a rule, collective. As the roles are distributed certain definite relations are created between the children which condition their behaviour towards each other. Consequently, creative collective play is a kind of school in which the child acquires creativity the rules and forms of human behaviour and of the reciprocal relations among human beings. The play of Soviet children, for instance, becomes a school in which they practically acquire the norms of socialist behaviour. This means, in other words, that to make creative collective play truly fruitful, it is necessary to overcome the prejudice that play is a free activity which tolerate not intervention from adults. In creative play, the objects which the children have to use may be fiction, e.g., the stick instead of the rifle, the chair instead of the car. The movements of the playing may also be fiction, e.g., imitations of the actual motions that the hand performs in shooting, instead of the real thing. But the contents of these actions and the relations among people concerned are not fictions, for the child always strives after truth and reality, as he prematurely understands them.

It must not, however, be assumed that the entire development of the child of pre-school age occurs in creative play. The play is but one of the ways in which the child comes to know the surrounding world. Introduction to culture is another important way to the child's mental and social development. The early cultivation of a proper attitude towards books is a matter of urgent necessity in this connection. We must not believe that the child's attitude to books is something that forms only at school, when he has learned to read independently. Rather, it develops at the earliest age. When the child sees that the grown-up memebers of his family read books attentively, when he realizes that books play an important part in their lives, he acquires a respect for books. When the child looks at pictures and listens to stories, he not only enriches mental outlook, but also becomes interested in books. This interest prepares him to learn reading and writing.

Instruction at school makes, from the first days, a series of demands on the child. From his very first days at school the child must learn how to listen to the teacher actively and without letting himself be distracted. He must memorize what he is asked to remember and not what he is interested in. Speaking in general terms, by going to school, the child enters upon a new stage of his development which gives his life a new content. A beginner at school must be prepared not only for a systematic acquisition of knowledge, but also for the new social relationships which are formed at school. It is important to form in the child a proper attitude towards his learning activity. His achievements must be given recognition, and even his smallest successes must not meet with indifference.

Creative activity manifests itself most clrearly in the field of production since under socialism worker is not an appendage of the machine. He is the creator of new and more perfected methods, the organizer of the process of production, the designer and the inventor. His creative work is a most important subject of psychological investigation. In the sphere of psychology of work, the investigators are faced with the very important problems of discovering the psychological requirements to different professions. This is not a matter of investigating aptitudes for different kinds of work, but of studying the conditions under which, within the work of profession, the necessary personal conditions are created, under which the work itself educates and changes the worker, A considerable number of studies of Soviet psychologists is also devoted to the investigation of creative work of artists - painters, musicians, actors, poets, writers -. This is also true of the work of scientists, mathematicians and inventors.

Boiko has recently tried to dicover the mechanisms of creative mental process, i.e., those which lead to the establishment of something new. He proposes, as a physiological explanation, an hypothesis that involves functional combination: that interaction of conditional - reflex processes occurs as a result of partial spatial coincidence of excitation of the cerebral cells. A partial sharing of the structural elements - as observed when different systems of connections function simultaneously and cause redistribution of nervous impulses entering the brain - such, broadly, is the material basis of creative, productive mental process according to this hypothesis.

To generalize an intellectual act means to distinguish from among the many diverse properties of an object those properties which are necessary for the fulfillment of the act. Gereralization is most successful when it occurs as early and as extensively as possible with the most diversified material possible - i.e., when all the cues except the distinguishing ones are extremely varied -. Under such conditions the child does not form associations between the action and its non-essential properties. Only as a result of the simultaneous development and generalization of an intellectual act does its true content become clear to the pupil. When this is achieved, the reverse process, - sequential abbreviation of the act - can begin. Constantly repeated operations whose results are known before hand are no longer needed. The pupil begins with the results and moves directly to the next operation for example, addition actually means combining several items into one group. Not even a great mathematician assumes the result of combination without thinking, but children at the very out-set of training actually do it, since for them, without actual combination there is no addition. However, they learn quickly that the results of the operation are always one and the same: the formation of a general group that one may then simply assume. Therefore, physical addition – combination - is the first thing excduled from the arithmetical "addition".

The substitution of abstract objects for sensory material has such great adventages that the energy spent on translating action to the verbal plane is justified. To the extent that earlier generalization of the objects and operations of an act occurred. To transfer to the verbal means a break with the direct presence of things and the inevitable formation of abstractions. With generalization from the concrete content of objects, the characteristics and properties essential for the act are discerned when such generalization occurs. When the act is transferred to the verbal plane, only the traits and characteristics of objects which are reinforced by separate words are selected as the meanings of the words. It is in the absence of the things themselves that they acquire abstract meaning. Abstractions are achieved only as a result of speech and are retained only in speech. They exist solely in the meanings of words. The child is able to deal with abstract material because of the audiomotor basis of these word meanings.

Analysis of the socio – historical and ontogenetic development of thinking and speech proceeds from the principle of their unity and reciprocity in the process of human cognitive activity. According to this principle, thought is not only expressed in speech but is formed and carried out in it. Language not only gives names to objects, but also permits the abstraction of their properties and relationships. Language also leads to their generalization in the form of concepts and their objectification in the form of words and other symbols. It is therefore concluded that abstract thinking is impossible without language – in the broader sense of the term. As the child assimilates the socially reinforced system of words and the grammatical rules of their changes and combinations in sentences he also assimilates all the associated logical forms and thought processes.

The following diagram illustrates the stages of the thinking process :

Problem

Appreciation of the problem

Appearance of Associations

Elimination of Associations
and Appearance of Supposition

confirmed

Not confirmed

Appearance and Check-up
on New Supposition

Confirmed

Solution of the Problem

Problem solving calls for a considerably higher level of analytic - synthetic activity. Mastery of numbers and of the four rules of arithmetics is necessary in order to do sums, but problem solving requires, in addition, mastery of a wide range of concepts, both concrete and abstract, reflecting quantitive relations between objects. When doing sums, the child is to select only one element the symbol, in order to choose the required arithmetical operation. In the case of a problem, the value sought, the information given in the content of the problem and the relationship between these are determined not only by the separate elements but by their combination which constitutes a certain complex -, i.e. to solve a problem successfully there must be synthesis at the level of complex analysis. Even in a single problem the same data can be interconnected in different ways, depending on the formutation of the question. With a compound problem, choice of operation is more difficult. The solution of new problems presupposes the formation of new connections which involves very precise analysis. New thoughts arise only on the basis of those formed in previous experience. In the process of solving new problems analysis involves particularly isolation of those old connections through which new connections can be established, and to find the relationship between them and the answer required it is necessary to select a number of intermediate elements and analyse them precisely. The analysis of the functional connections is directed to finding regularities which throw light on the interconnections between what is given and what is sought for. The analysis of separate facts and of the functional relations between them permits the discovery of certain relations between the facts and facilitates the choice of the necessary operation.

The brain mechamisms of the thinking process and of all other human mental functions, are, as already repeatedly stressed, the tertiary zones of the frontal cortex as well as the overlapping zones of the cortical boundaries of the different analysers which combine the activity of the different cortical areas taking place and which comprise 43 per cent of the total mass of the cortex. This indicates the increased complexity of the functional relationships between the analysers and is reflected morphologically by the fact that with the progressive growth of the nuclear zones of analysers (*Brodmann's areas* 17, 18, 19 areas, for instance, are the nuclear zones of the optic analyser; *and areas* 41, 42, 22 *are the nuclear zones of the auditory analyser*) over the surface of the hemispheres, overlapping zones of the cortical endings of the analysers (tertiary field of the cortex) are formed. "They are associated with most complex forms of integration of conjoint activity of the visual, auditory and cutaneo - kinaesthetic analysers. Since the tertiary fields of the cortex lie outside the nuclear zones proper, their injury or stimulation is not accompanied by any marked loss or modification of the specific functions of the analysers ... In contrast to the groups of neurons of the nuclear zones, the numerous groups of neurons composing the tertiary fields of the cortex are almost completely lacking in specific analysers functions, having made the complete functional transition to the adequate reflection of the most complex forms of spatial and temporal relationships between groups of actual stimuli and to the handling of these relationships during the organism's active response to the outside world... The extensive area in man occupied by the overlapping zones of the cortical endings of the analysers is subdivided into a series of fields.

The variations in the microstructure of these fields, like those in their functional significance, are determined by the topographical relationship between these fields and the bordering fields of the nuclear zones.... The most prominent feature of the architectonic and neuronal pattern of the overlapping zones is the tertiary association of the cortex represented by the pyramidal and stellate cells of the highest layers and sublayers of the cortex - the last to become differentiated in the evolution of mammals - namely, the middle and upper sublayers or layers III and II. The neurons of this part of the cortical gray matter dispatch, receive, and relay the most intricate and subtly differentiated streams of impulses responsible for the functional integration of the neurons of the nuclear zones into increasingly diverse and differentiated working constellations, corresponding to the higher mental functions to be carried out. Besides having these highly differentiated, mulilateral associative connections of the tertiary cortical fields are distinguished from the primary and secondary fields by the presence of extremely complex chains of projection relays into the subcortical divisions of the analysers". (1)

"The primary, secondary and tertiary fields of the occipital, temporal and parietal regions of the cortex ... are concentrated in the posterior portion of the hemispheres, behind the central sulcus. The cortical fields of the frontal lobe of the brain situated anteriorly to this sulcus and including the precentral region and the frontal proper, have a number of functional and structural features that distinguish them essentially from the part of the cortex posterior to the central sulcus... In the course of phylogenesis this region became differentiated from the single sensorimotor cortex and was divided into two fields: a primary, giant pyramidal or motor zone, known as area 4 (the central motor area,) and the secondary premotor zones, known as *areas* 6 *and* 8 (*the peripheral motor areas*). The general structural and functional features of these fields and their connections with the subcortical divisions of the brain have much in common with those of the primary and secondary fields of the occipital, temporal and postcentral cortex. Nevertheless, there are important differences due to the fact that in the cortical organization of the whole of frontal lobe, in contrast to that of the posterior portion of the hemisphere, the accent is on the performance of the coordinated and goal - directed acts by the organism in relation to the external world in response to perceived group of stimuli... The subdivisions of the motor zone of the cortex into a motor areas and premotor areas was the result of progressive structural differentiation of the originally single cortical region in the course of evolution in response to the growing complexity of the range of cortically directed active movements. The higher development and perfection of the whole sphere of voluntary goal-directed acts was associated with the formation of the tertiary fields of the frontal region proper. These fields, occupying in man about one quarter of the entire surface of the cortex, belong to the phylogenetically younger divisions of the neocortex. They were formed as a result of the growth, anteriorly, of the elements of the same type of neuronal organization as lies at the basis of the motor zone of the motor zone of the cortex... *Just as the tertiary fields of the posterior part of the hemisphere are related to the most highly generalized and integrated forms of perception of the eRternal world, so also the tertiary fields of the prefrontal part of the hemisphere are related to the most highly integrated form of goal directed activity".* (1)

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(1) Polyakov, G. I., "Modern Data on the Structural Organization of the Cerebral Cortex, "in Luria, A.R., Higher Cortical Functions in Man, London, Tavistock Publications, 1966, PP. 50—53.

It is, therefore a firmly estebalished fact that there are *two major tertiary zones in the cerebral cortex of man: the posterior (situated at the borders of the parietal, temporal and occipital regions of the cortex) and the anterior situated in the prefrontal area of the hemispheres. One of them, the posterior, is mainly responsible for the perceptual images of the external world and the other, the anterior, is the brain mechanism of conception. Both of them are uniquely human cortical formations distinguishing the human brain qualitatively from the brains of the rest of the animal kingdom. These are the overlapping zones (areas: 5, 21, 37, 39, 40). These cortical formations lie on the boundary between the occipital (visual), temporal (auditory) and post central cortex, and are responsible for enabling groups of several analysers to work cooperatively, There are also other cortical human formations (areas: 9, 10, 46) which constitute the frontal region of human cerebral cortex, and are related to the most gereralized forms of abract thinking and creative imagination.*

Potential genuis in the field of art is of two kinds: the first category graps the objective world mainly in the form of

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(1) Polyakov, G.I. "Modern Data on the structural Organization of the Cerebral cortex", Luria, A.R., Higher Cortical Functions in Man, Tavistock Publications, London, 1966. PP. 53—58.

sensory visual perception, and expresses its impressions in terms of sensory visual images as in the case of painters and poets. The second category grasps the objective world mainly in terms of its sensory auditory perception and expresses its impressions in terms of sensory auditory images as in the case of musicians. It is possible, accordingly, to postulate that perhaps there are certain morphological and physiological features as well as cyto-architectonic of the overlapping zones of the occipital cortex of the potential genuis of the first category. On the other hand, the morphological and physiological characteristics as well as cytoarchitectonics of the overlapping zones of the temporal cortex of the potential genuis of the second category should, likewise, be different from the rest of human beings.

In the case of the potential genuis in mathematics and theoretical physics, for instance, there are reasons to suppose that his prefrontal cortex, or, to be more precise, the prefrontal divisions of the cortex (areas: 9, 10, 46) are of a unique characteristics in its morphology, physiology and cytoarchitectonics since mathematicians and theoreticians, especially at the highest level of abstraction, comprehend the objective world mainly in terms of conceptual mental images and express their impressions in terms of symbols and mathematical equations.

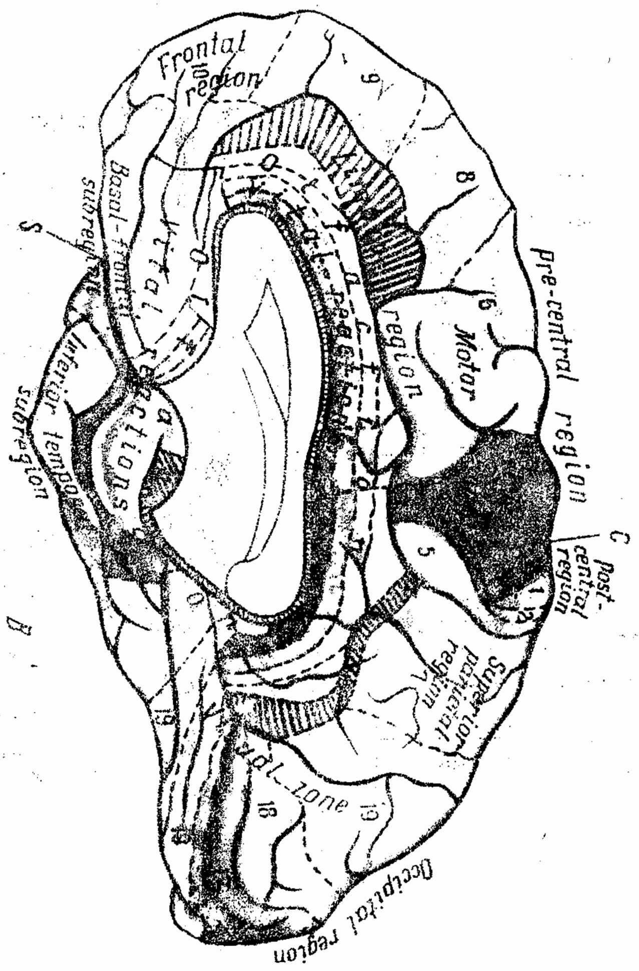
All other normal people below the rank of genuis, share common brain mechanisms, with, of course, individual differences, but without marked neorological distinction or signification. This means that all of them are potential creative to this or that extent, and that the actual creative *among them are those who enjoy favourable social conditions and a special intellectual climate in which they utilize their mechanisms to the utmost of their potentialities in a particular area of human endevour which concerns them most intimately.*

There is, in addition to what has been said concerning the potential genuis in music such or Beethhoven, for instance other brain mechanisms responsible for the fine movements of the fingers, and it is reasonable to suppose that the potentially genuis musician has also a unique tertiary or overlapving zone (Brodmann's area 10) of his motor cortex.

In order to stress once more the importance of this neurological trait it is imporant to submit the following remarks: All abilities are formed and developed only in the process of activity, primerily in activity which of necessity requires that ability, which cannot be undertaken without it. The abilities needed for the pursuit of art are therefore formed and developed in the process of artistic activity. But since such abilities are created on the foundation of cortical prerequisites in the child, different children undergoing the same form of education will manifest widely varying abilities. In aesthetic perception the significance of the sensory form of things - "sight" and "hearing" themselves - differ from that in other aspects of perception. What is important in ordinary, everyday perception is not so much the "sight" and "sound" of things as their meaning. To see and hear with eyes and ears of an artist - a painter, an actor - is something entirely different; music calls for hearing of a special kind. This applies equally to poetry which calls for a developed and discriminately perception of the sounds of speech. From a psychological point of view, the concept of "poetical hearing" is as legitimate and necessary as that of "musical hearing".

Imagination is the creation of new forms with the material of earlier perception. It plays a vital role in every kind of creative work. Nowhere does imagination have such exceptional importance as in art, in the process of artistic creation. Forms of imagination have place in science only when the scientists creative thought is incorporated in material. In art the creation of forms is the direct task of the creater – the writer, painter, composer, actor – embodies in form his own ideological intentions. Imagination, therefore, takes a central place in the process of artistic creation, and this means that all creative activity in the course of education can serve as a powerful means of developing imagination. On the other hand, a factor unique in visual perception is the possibility of wide simultaneous synthesis, enabling a whole situation to be perceived at the same time (for example, the simultaneous examination of a picture). It is important to suppose that this type of perception is not a function of visual (occipital) cortex only, but requires the close participation of the parieto – occipital zones. These are apparently responsible for the conversion of the successive formation of a stimutation into simultaneous comprehension of a complete optically perceived situation.

Since all men of genuis are unique in their devotion to their work and that attention is constantly concentrated in their work, it is possible to suggest that their reticular formation, the source of the human mental energy, must also *have unique, qualitative morphological and physiological characteristics distinguishing it from that of all other normal human beings. In addition, the social incentives are essential for the stimulation and sustaining their attention.*



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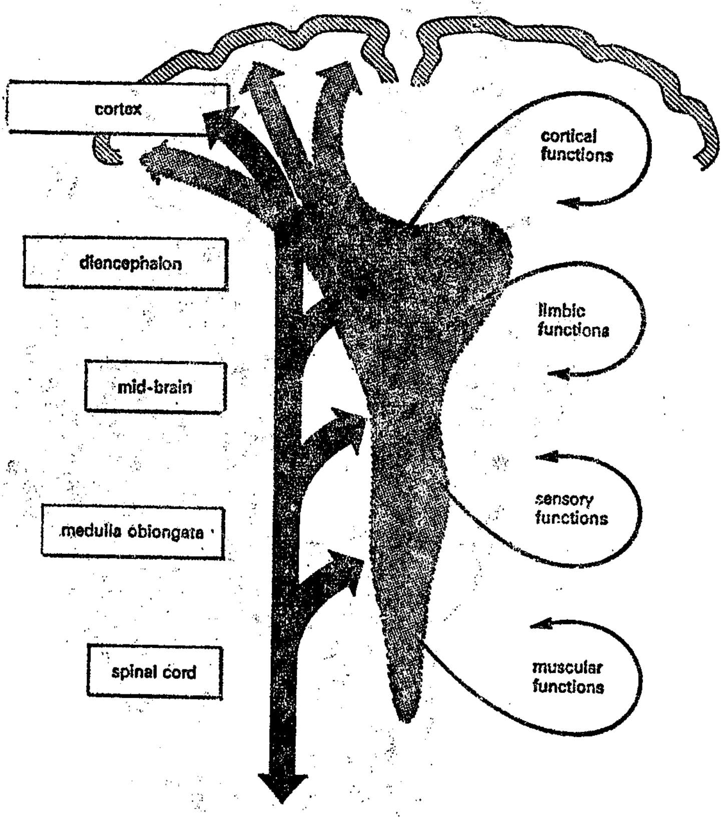

Scheme of the activating reticular formation (after Luria)

It is of interest to point out, in conclusion, that there is a radical difference between the calculation ability in mathematics and creative mathematical ability. There were several boy calculators - all famous in their time, but totally lacking in creative problem – solving. Among them are the following:

1. Truman Salford: the son of a Vermont farmer in the United States. When he was six years old he could calculate mentally the number of barley cons in 1,040 rode = 617,760. Once he was asked to multiply in his head: 365, 365, 365, 365, 365, 365, by 365, 365, 365, 365, 365, 365. He flew round the room like a top, pulled his pantaloons over the top of his boots, bit his hands roled his eyes in their sockets, sometimes smiling and talking, and then, seeming to be in an agony, in not more than one minute, replied, replied: 133, 491, 850, 208, 566, 925, 916, 658, 299, 421, 583, 225.
2. Zerab Colburn the son of a 19th century Vermont farmer also. At the age of seven he was asked: What number multiplied by itself will produce 998, 001? He answered in less than four seconds 999. He was also asked how many seconds there are in eleven years and answered: 346, 989, 000 in four seconds, excluding leap years. At the age of eight, he raised the number 8 to 16 power in his head: 281, 474, 976, 710, 656. He was also asked the square root of 106, 929, and before the number could be written down he immediately answered: 327. He was then asked to name the cube root of 268, 336, 125 and with the same ease and promptness he replied 645. He was then asked to give the cube root of: 413, 993,

348, 677 and gave correct answer in five seconds. He was examined by Laplace and others of the French Academy. He could not tell how the answer came to his mind and was entirely ignorant of the common rules of arithmetics at the time, and could not perform on paper a simple sum of multiplication or division.

3. Gegre Parker Bidder who was born in Morton - Hampstead in England. At the age of ten he was asked: What is the compound interest of £ 4,444 for 4,444 days at $4\frac{1}{2}$ per cent annum? He gave the answer £ 2,434: lbs. $5\frac{1}{4}$d. At eleven he was asked to divide 468, 592, 413, 363 by 9,076. In one minute he answered correctly. At thirteen he was asked to find the number whose cube less 19 muliplied by that cube shall be equal to the cube of 6. He answered instatously. His father took him round the country to give public exhibitions, and found it highly profitable. As a result his education was reglected.

4. Johann Dase who was born in Hamburg, Germany. When he was thirteen he reckoned the natural logarithms - 7 places - of the numbers from 1 - 1,005,000. He multiplied 79, 532, 853 by: 93, 758, 479 in 54 seconds. He could multiply two numbers each of 20 figures in 6 minuted. He could extract mentally the sequare root of a number of 100 figures in 52 minutes.

5. Vito Mangiamele was a French shephered with a remarkable calculating ability. At the age of ten he had demonstrated his ability before the French Academy and supplied the cube root of 3,796,416 in 30 seconds.

6. Jacques Inaudi the Italian shephered. At the age of seven he could multiply five figures by five figures instantaneously. He lived by public exhibitions, and demonstrated his calculating ability before large aduience in almost every capital in Europe and in the United States.

7. Jededish Buxton the English man who was born in Derbyshire - with low intelligence. It is said that at maturity his mental age was ten. One occasion he squared mentally a number of 39 figures.

8. Jean Fleury: one day in 1912 he was told the date and the day of the week and was asked what day 22nd May 1908 had been? He gave the correct answer in five seconds.

There are other cases known all over the world at the present and some cases are found in Iraq recently. Their brain mechanisms are not discovered. Similar cases are also known with exceptional memory. Famous among them is the case studied by Luria(1) for almost 30 years: "The actual beginning of this account" said Luria "dates back to 1920's, when I had only recetly begun to do work in psychology. It was then a man came to my laboratory who asked to test his memory. At that time the man - let us designate him. S. - was a newspaper reporter who had come to my laboratory at the suggestion of the paper's editor. Each morning the editor would meet with the staff and hand out assignments for the day -lists of places he wanted covered, information to be obtained in each. The list of addresses and instructions was usually fairly long and the editor noted with some surprise that S.. never took any notes. He was about to reproach the reporter for being inattentive when, at his urging, S. repeated the entire assignment word for word... The editor sent him to the psychology laboratory to have some studies done on his memory. - I gave S. series of words, then numbers, then letters, reading them to him slowly or presenting them in written form... He repeated the material exactly... I increased the number of elements in each series, giving him as thirty, fifty, or even seventy words or numbers, but this, too, presented no problem for him... The experiment indicated that he could reproduce a series in reverse order - from the end to the beginning - just as simply as from start to finish... It was of no consequence to him whether the series I gave him contained meaningful words or nonsense syllables, numbers or sounds: whether they were presented orally or in writting". (1)

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(1) Luria, A.R., The Mind of a Mnemonist, London. Jonathan Cape, 1969.

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ببغداد ١٣٢٧ لسنة ١٩٧٦

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